UNLOCKING LARGE-SCALE ACCESS TO COMBINED MOBILITY THROUGH A EUROPEAN MAAS NETWORK.

Deliverable D3.5
IMOVE Data Translators and Reference Information Model – final version

This report is part of a project that has received funding by the European Union's Horizon 2020 research and innovation programme under grant agreement number 723314.

Deliverable D3.5

IMOVE Data Translators and Reference Information Model – final version

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Main editor:	Vassilis PSALTOPOULOS

Editor name	Organisation
Vassilis PSALTOPOULOS	Institute of Communication and Computer Systems
Nikolaos TOUSERT	Institute of Communication and Computer Systems
Michal CERTICKY	Ceske Vysoke Uceni Technicke V Praze
Jan HRNCIR	Ceske Vysoke Uceni Technicke V Praze
Corrado ALESSO	Urbannext SA
Roberto YANEZ	Mosaic Factor SL
Alessandro BARISONE	Softeco Sismat SRL

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Executive Summary

This deliverable presents the final outcomes of Task 3.3: Reference MaaS Data Model and provides the final data modelling specifications for all software enablers developed in the context of the IMOVE project. The major outcome of the task, is the definition of the Reference Information Model for the implementation of the IMOVE ecosystem, taking into account the results related to the regulatory framework for MaaS systems. Currently there is no consistency in data models for exchanging and storing information. Mobility services and MaaS operators in Europe are defining and using their own unique data models which makes it difficult to cooperate. By designing a standard data model for MaaS, IMOVE is able to further support the collaboration and cooperation efforts of different mobility actors throughout Europe.

IMOVE's reference MaaS data model has been developed with consideration of the needs and constraints of the Living Labs and in close cooperation with developers that develop the IMOVE's software enablers. The deliverable also contains the software enablers, which have been designed specifically for the conditions of the internal IMOVE ecosystem in order to support specific MaaS-related operations and thus enabling and facilitating interoperability among MaaS systems. The deliverable contains information on the data modelling processes that were used to develop the IMOVE reference data model, according to the needs of the project and presents the overview of the model together with the software enablers. All data entities that each software enabler holds with reference to their attributes is described and the Reference Information Model is presented as a graphical representation. The deliverable also includes data translators, explaining their importance in the IMOVE ecosystem, the design process and the functionalities they serve.

The overall goal is to materialize the concept of scaling and building of stable business operations, ultimately paving the way for roaming capability for MaaS users at the European level. This is achieved by making these versatile data and service resources currently in operation interoperable and compatible and enable B2C and B2B transactions. An innovative reference data model and a complete set of tools is thus mandatory, as to harmonize the data inputs and then manipulate them to suit the data format requirements of each actor that requests them.

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Abbreviations and Acronyms

B2B	Business to business
B2C	Business to customer
CA	Consortium Agreement
D	Deliverable
DoA	Description of Action
ERB	Ethics Review Board
GA	Grant Agreement
GDPR	General Data Protection Regulation
ICT	Information and communication technology
ITS	Intelligent transportation systems
LL(s)	Living Lab(s)
PTA	Public Transport Authority
RIM	Reference Information Model
TSP	Transport Service Provider
UML	Unified Modeling Language
WP	Work Package
XML	eXtensible Markup Language
YAML	YAML Ain't a Markup Language

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1 INTRODUCTION

IMOVE is a research and innovation action project offering innovative concepts, systems and services, experimenting and validating 'mobility as a service' models and operating conditions in different cities around Europe by supporting and running Living Labs with overall goal to unlock large-scale success to combined mobility through a European MaaS network. The key objective of the project is to accelerate the deployment and unlock the scalability of MaaS schemes in Europe, paving the way for a roaming service for MaaS users at the European level.

Mobility-as-a-Service enables travel through a single platform. However MaaS currently represent a large group of scattered services aimed at simplifying travel through the combination of information, payment and/or booking of mobility services. It can be to offers on-demand, real-time combinations of transport methods such as car and bike sharing, taxis and car rentals/leases.

The benefits of MaaS include easy route planning, as real-time route planning allows users to plan journeys using multiple transport methods, based on intelligent suggestions derived from their personal preferences. Simplified payments, as MaaS users can pay for transportation using phones, smart watches and bankcards, before or after their journey, or on a subscription basis. Personal touch, as MaaS aims to be a fully personalized service that builds relationships between users and the transport provider. By using big data, two-way communication and constant user feedback, MaaS systems have the potential to become the fully customer-focused transportation platforms.

MaaS initiatives have been tested in Europe however, encountered several obstacles which prevented scaling and stable business operations. IMOVE focused on innovative business and technology enablers investigation to concretely put into action, accelerate and scale up the MaaS market deployment in Europe, ultimately paving the way for a roaming capability for MaaS users at the European level. The technology enablers, or software enablers designed to empower the MaaS schemes was carefully designed and developed by IMOVE. The components included systems for real-time collection of fine-grained data on mobility user needs, habits and preferences as well as components enabling the exchange of information and enhancing seamless interoperability among different MaaS subsystems and multiple MaaS schemes. These software enablers were investigated and validated in five the European Living Labs, Berlin, Turin, Gothenburg, Madrid and Manchester.

The objective of this document is to demonstrate the finalized IMOVE's Reference MaaS Data Model for the implementation and development of the project's cornerstones, the software enablers, that can facilitate the scalability, roaming between and acceptance for the MaaS paradigm across Europe. Data translators will also be demonstrated and described for the communication of IMOVE with the external IT systems. Software enablers was developed by Softeco, Mosaic, URBI, CVUT and ICCS contributed in the data modelling process and the definition of the data translators when needed.

1.1 BUSINESS AND TECHNOLOGY ENABLERS

The three fundamental areas of innovation to foster MaaS development consist of:

- Scalability unlockers in terms of business models and guidelines, regulatory aspects and policies to promote travel behavior change and modal,
- The design and implementation of software blocks otherwise called software enablers targeting Mobility as a Service operations
- Information exchange framework, in terms of reference data model, management policies and analytics.

The set of components developed (software enablers) aim at specific business areas and offer a broad range of functionalities and services to benefit all the involved stakeholders. They are self-contained pieces of

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software intended for a specific MaaS business aspect. They implement a coherent set of functionalities that can be self-consistent or part of more complex workflows in cooperation with other enablers, this is illustrated in Figure 1.

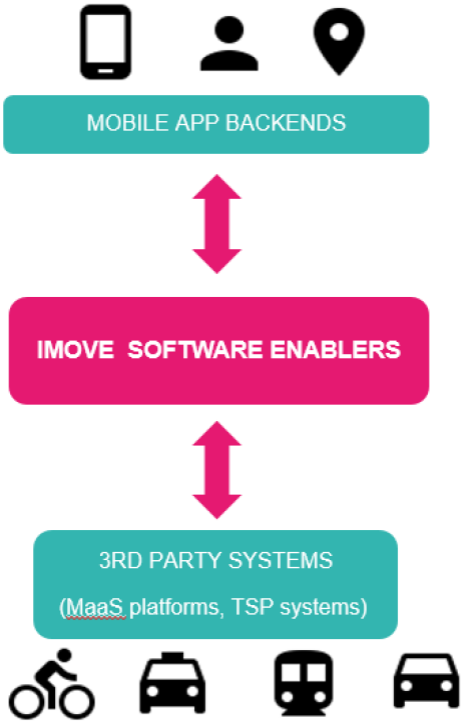

Figure 1. IMOVE Software enablers concept

Each software enabler is part of an interconnected ecosystem, as it implements complex workflows possibly involving different types of interactions, either with other software enablers within IMOVE, with the infrastructure of a MaaS operator in order to gain access to transportation service providers IT platforms. They can also be used with mobile application backends, to supply functionalities to app end users.

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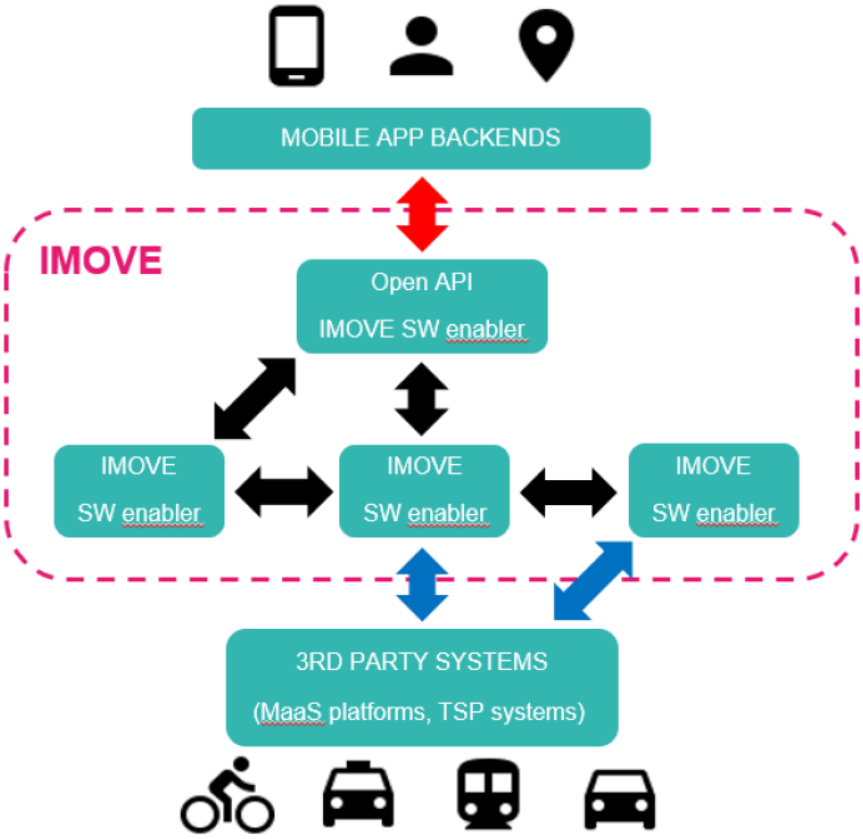

Figure 2 IMOVE Software enablers communication framework

To facilitate the data and information exchange between the IMOVE components, as demonstrated on the communication framework on Figure 2, it is crucial that a common reference data model is defined. A set of processes and close collaboration between the software developers developed into to a concrete and stable version of the IMOVE reference data model, which can be applied and used by any party interested in adopting the IMOVE solution even after the project. The data model serves as a reference point for corporates or organizations that would like to build on top of the concept use the software block to scale up their business activities and even extend it to a more commercial usage.

1.2 PURPOSE OF THE DELIVERABLE

This deliverable contains the final outcomes of the Task 3.3: “Reference MaaS Data Model” for the definition of the reference MaaS data model for the IMOVE components as well as for all necessary interfaces between the IMOVE actors to connect existing and external services.

Currently there is no consistency in data models for exchanging and storing information. Mobility services and MaaS operators in Europe are defining and using their own unique data models which makes it difficult to cooperate. By designing a standard data model for MaaS, IMOVE is able to further support the collaboration and cooperation efforts of different mobility actors throughout Europe. IMOVE’s reference MaaS data model has been developed with consideration of the needs and constraints of the Living Labs and in close cooperation with developers that develop the IMOVE’s software enablers. Furthermore, the creation of a data model also involved the task of defining the data translators. Data translators are needed to effectively integrate the heterogeneous actors, services and platforms. This set of different data translators are transforming data from the IMOVE reference data model to underlying MaaS and services specific models and vice versa. IMOVE has thus developed a complete set of tools containing the interfaces and adapters needed for interfacing

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service providers and other third party services according to the Living Labs specific needs. One such need was the data privacy, and thus data translation tools were developed to transform data from unprotected to protected format, in order to ensure security and privacy. The translating/interfacing algorithms is an essential component of the IMOVE platform and was implemented and tested in the Living Labs iterations.

1.3 STRUCTURE OF THE DELIVERABLE

The first chapter serves as an introduction to the generic concept of MaaS, software enablers and data reference model.

The second chapter focuses on the tools used by the involved partners in the second iteration of the data modelling process and presents the revised and finalized IMOVE data model overview.

The third chapter comes to divide all data entities per software enabler that utilizes them and refers to their attributes revised.

Chapter four presents the finalized version of the Reference Information Model as a graphical representation demonstrating all data entities involved and their relations.

Chapter five focuses on the data translators (data adapters), as essential parts of the IMOVE solution. There, all developed and deployed data adapters will be documented and described to demonstrate the functionalities they serve.

On the conclusions section the findings of this process are presented, and it is marked the importance of a common reference data model for the scalability of MaaS throughout Europe and the facilitation of the roaming adoption.

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2 DATA MODEL

The data model developed in the scope of the project refers to the logical inter-relationships and data flow between different data elements involved to form the software enablers' communication framework. It describes all the data structures handled by the software components to perform their certain functionalities and documents how data is stored and retrieved. The models facilitate digital communication, business and technical development by accurately representing the requirements of the information system and by delivering the responses needed for those requirements. It represents what data is required in which format and the cardinalities of the used data structures for different business processes.

2.1 SWAGGER

The second iteration in the definition of the reference data model and the APIs specifications for the software enablers brought up the usage of Swagger. The developers of the software enablers decided in common to use this tool for the design purposes. Swagger simplifies API development for users and teams as an open source and professional toolset. It's a tool that models schemas which share common properties. Instead of describing properties for each schema repeatedly, the schemas can be described as a composition of the common property set and schema-specific properties. Swagger Editor was chosen because it's the first editor built for designing APIs with the OpenAPI Specification (OAS), and has continued to meet the needs of developers building APIs with OAS. The Editor validates the design in real-time, checks for OAS compliancy, and provides visual feedback on the go. Swagger tools like the Swagger Editor and SwaggerHub provide a YAML editor with a visualization panel for developers to work in and see how the API will looks and behave for the end consumer. SwaggerHub is adopted by more than 100k API Practitioners, more than 40k organizations and has supported more than 200k API projects. An online project was created and the initial data model and API specifications were migrated there.

```
# tags are used for organizing operations
tags:
- name: Identity_Manager
  description: identity manager endpoints
- name: User_Tariffs_Manager
  description: User Tariffs Manager endpoints
- name: Mobility_Tracker
  description: Mobility Tracker endpoints
- name: Preferences_Manager
  description: Preferences Manager endpoints
- name: Notification_Manager
  description: Notification Manager endpoints
- name: Roaming_Manager
  description: Roaming Manager endpoints
- name: Price_Manager
  description: Price Manager endpoints
- name: Mobility_Organizer
  description: Mobility Organizer endpoints
- name: Booking_Manager
  description: Booking Manager endpoints
- name: Incentives_And_Gamification Manager
  description: Incentives & Gamification Manager endpoints
```

Figure 3 Swagger API definitions

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All APIs were carefully revised and adapted according to the needs to support internal and external compliance. The software enablers API definitions on Swagger are briefly described in Figure 3 above.

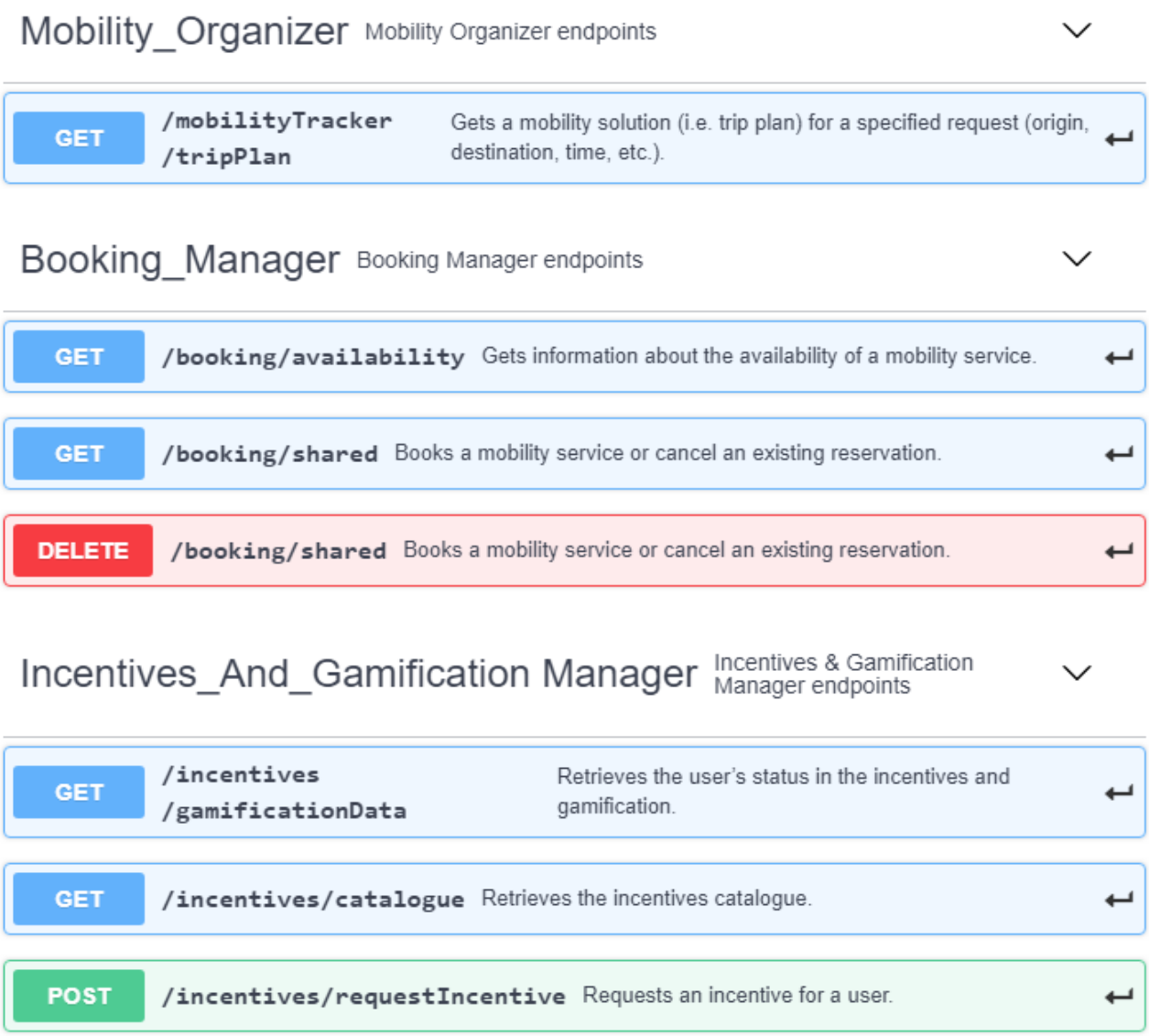

Figure 4 Example: Mobility Organizer endpoints

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All data entities used by software enablers were also modeled. Swaggerhub offered real time validation of the design to make the model concrete and stable and supported harmonization and reusability of all data entities.

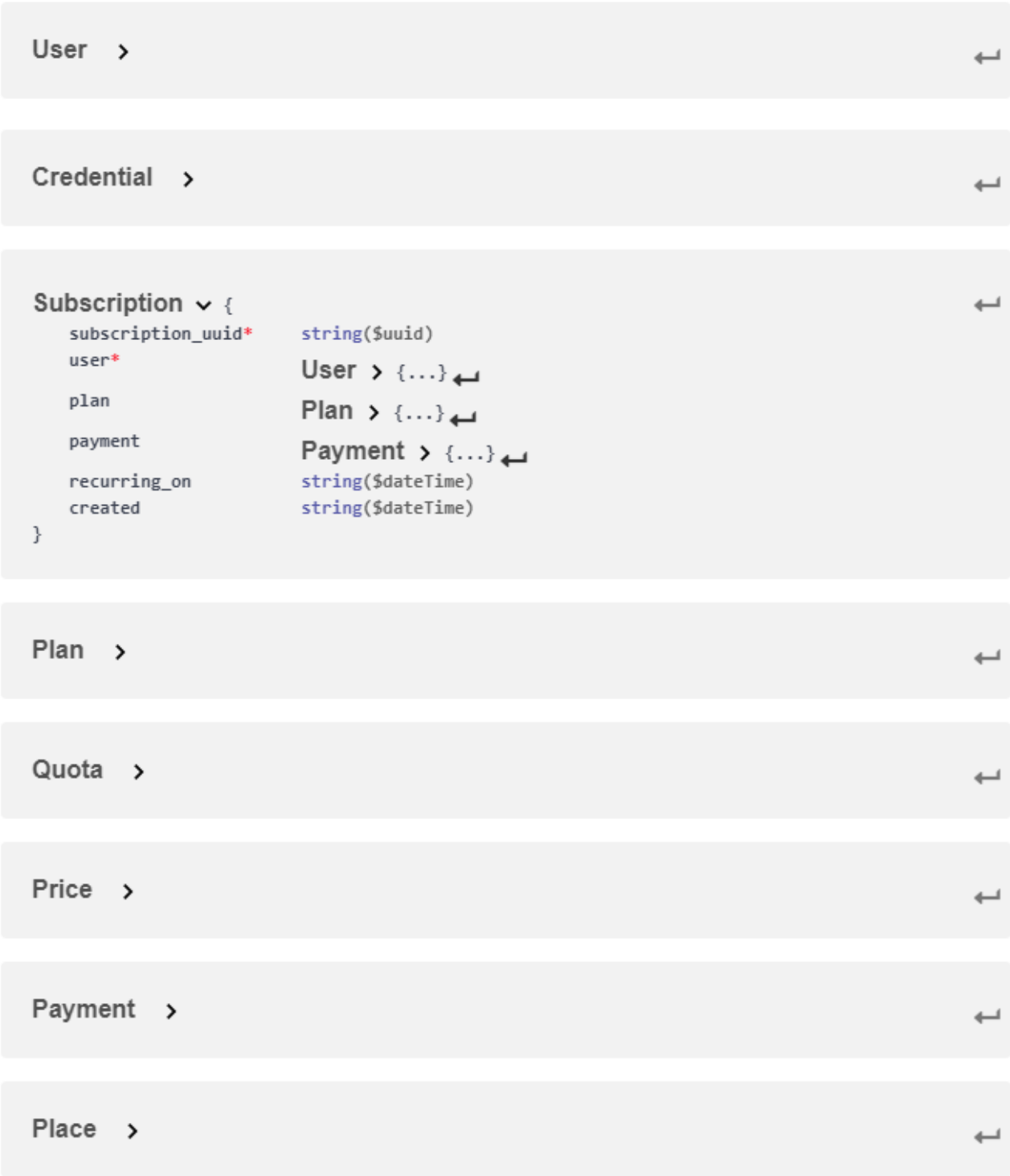

Figure 5 Example: Subscription Entity definition

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2.2 GitLab

IMOVE is a project with multiple developers working in parallel. So a version control system like GitLab was needed to ensure there are no conflicts in the definitions between the developers. Additionally, due to the nature of the project the data model and the APIs had to be changed often. GIT supports version controlling and it is a system which allows developers either to proceed or to revert and go back to an older version of the files in case of errors. It is designed for coordinating work among programmers, but it can be used to track changes in any set of files. Its goals include speed, data integrity, and support for distributed, non-linear workflows. GitLab started as an open source project to help teams collaborate on software development. By delivering new functionality at an industry-leading pace, GitLab now provides a single application for the entire software development and operations lifecycle. GitLab provides everything needed to Manage, Plan, Create, Verify, Package, Release, Configure, Monitor, and Secure applications. GitLab is a complete DevOps platform, free and open-source software distributed under the terms of the GNU General Public License version 2 delivered as a single application.

To support collaboration and minimize the risks of errors, the IMOVE team adopted GIT for the APIs specification and the data modeling process. The first version of the YAML file derived from Swagger was uploaded on a repository created as a master file.

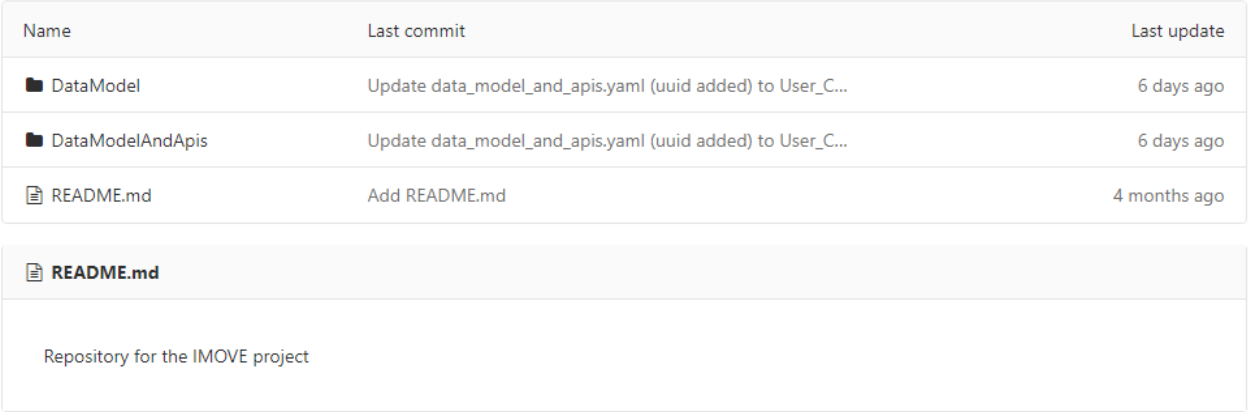

Figure 6 IMOVE GIT repository

Every time someone proposed changes to be made to the project on the master file and committed, a merge request was issued on a separate branch. The merge request was handled by the relevant responsible partner and was embodied with the master file.

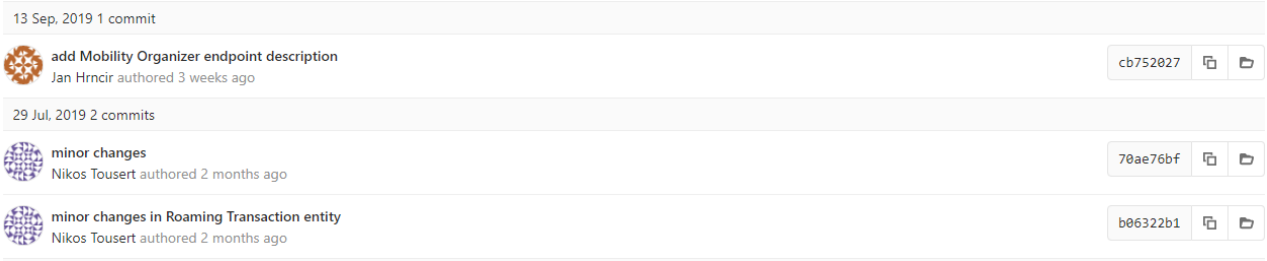

Figure 7 IMOVE repository updates

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The end result was a finalized YAML file which was later used to produce a pictorial representation of the IMOVE ecosystem and create the data tables that will follow in the relevant sections.

data_model_and_apis.yaml 59.4 KB

Edit | Web IDE | Replace | Delete

```yaml
swagger: '2.0'
info:
  description: IMOVE Data Models and APIs
  version: 1.0.0
  title: IMOVE Inventory API and Models
  # put the contact info for your development or API team
  contact:
    email: you@your-company.com

  license:
    name: Apache 2.0
    url: http://www.apache.org/licenses/LICENSE-2.0.html

# tags are used for organizing operations
tags:
- name: Identity_Manager
  description: identity manager endpoints
- name: User_Tariffs_Manager
  description: User Tariffs Manager endpoints
- name: Mobility_Tracker
  description: Mobility Tracker endpoints
- name: Preferences_Manager
  description: Preferences Manager endpoints
- name: Notification_Manager
  description: Notification Manager endpoints
- name: Roaming_Manager
  description: Roaming Manager endpoints
- name: Price_Manager
  description: Price Manager endpoints
- name: Mobility_Organizer
  description: Mobility Organizer endpoints
- name: Booking_Manager
  description: Booking Manager endpoints
- name: Incentives_And_Gamification_Manager
  description: Incentives & Gamification Manager endpoints




paths:

```

Figure 8 IMOVE Swagger yaml file creation

2.3 IMOVE Revised Data Model Overview

The IMOVE system is composed of the following software enablers:

Identity Manager: handles the concept of an IMOVE MaaS user and its connection to external services.

User Tariffs Manager: manages the user's subscriptions, credit and quotas related to transportation services.

Mobility Tracker: an enabler responsible for collecting the mobility-related information about the users and providing this information to other software enablers.

Preferences Manager: provides the information about the user's preferences, habits, needs etc.

Notification Manager: stores the messages generated by other enablers and interconnected systems to be delivered users via their mobile apps.

Roaming Manager: enables and ensures the interconnection of multiple MaaS operators enabling for inter-roaming and cross border roaming services.

Price Manager: is responsible for collecting and storing the information about the prices of all the services provided by local transport providers.

Mobility Organizer: is a software enabler introducing functionalities related to trip planning into the IMOVE system's architecture.

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Booking Manager: enables other software enablers, and ultimately the users, to perform service bookings and purchases.

Incentives & Gamification Manager: takes care of the incentivization mechanisms, designed to influence user's behaviour in a desirable way (via rewards, achievements, etc.).

The finalized version of the IMOVE reference data model consists of **43** Unique Data entities/types and **5** predefined enumerations handled by those **10** software enablers and outlines the data entities/types, the data attributes, and the relationships or associations with other data. It provides a generalized, user-defined view of data and had an essential role for the design of the databases of the software components of the IMOVE platform. This data model was used to structure and organize data.

Below, a cumulative table of the data entities and the predefined enumerations that surround the reference data model is presented.

Table 1 IMOVE data entities and predefined enumerations cumulative table

#	Entity

1	User{
	user_uuid* string($uuid)
	phone string
	}

2	Credential{
	credentials_uuid* string($uuid)
	user* User{...}
	provider MaaS_Provider{...}
	credentials string
	}

3	Subscription{
	subscription_uuid* string($uuid)
	user* User{...}
	plan Plan{...}
	payment Payment{...}
	recurring_on string($dateTime)
	created string($dateTime)
	}

4	Plan{
	plan_uuid* string($uuid)
	name* string
	price Price{...}
	enabled_providers [...]
	quota Quota{...}
	}

5	Quota{
	sharing_credit Price{...}
	pt_credit Price{...}
	taxi_credit Price{...}
	}

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6	**Price**{
	amount number($float)
	currency string
	}

7	**Payment**{
	payment_uuid* string($uuid)
	user* **User**{...}
	payment_provider string($enumeration)
	payment_token string
	payment_type string($enumeration)
	}

8	**Place**{
	place_uuid* string($uuid)
	description **InfoTextType**{...}
	period [...]
	location **Location**{...}
	}

9	**Trip**{
	trip_uuid* string($uuid)
	trip_origin* **Location**{...}
	trip_destination* **Location**{...}
	user_uuid string($uuid)
	legs [**Leg**{...}]
	price **Price**{...}
	}

10	**Ranked_Trip**{
	trip **Trip**{...}
	rank number ($integer)
	}

11	**Alternative_Trip**{
	trips [**Trip**{...}]
	by_CT boolean
	by_QoS boolean
	by_TT boolean
	weather string($enumeration)
	traffic string($enumeration)
	}

12	**Ranked_Transport_Mode**{
	transport_mode string
	rank number ($integer)
	}

13	**Leg**{
	mode_of_transport string($enumeration)
	leg_origin **Location**{...}
	leg_destination **Location**{...}
	leg_start_time string($dateTime)
	leg_end_time string($dateTime)
	transport_provider_uuid [string($uuid)]
	user_uuid string($uuid)
	price **Price**{...}
	}

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14	Weekly_Schedule{
	week_day number($integer enumeration)
	arrival_time string($dateTime)
	departure_time string($dateTime)
	}

15	Monthly_Schedule{
	month_day number($integer enumeration)
	arrival_time string($dateTime)
	departure_time string($dateTime)
	}

16	Schedule{
	weekly [Weekly_Schedule{...}]
	monthly [Monthly_Schedule{...}]
	}

17	Recurrent_Place{
	place Place{...}
	schedule Schedule{...}
	}

18	Recurrent_Trip{
	trip Trip{...}
	schedule Schedule{...}
	}

19	Track{
	location Location{...}
	time_stamp string($dateTime)
	}

20	User_Preferences{
	user_uuid string($uuid)
	context_mobility_preferences [User_Context_Preferences{...}]
	quality_service_preferences User_Quality_Service_Preferences{...}
	transport_type_preferences User_Transport_Type_Preferences{...}
	budget Price{...}
	}

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21	**User_Context_Preferences**{
	user_uuid string($uuid)
	context_type Context_Type string
	Enum:
	Array [3]
	context_value {
	oneOf -> Distance
	string
	Enum:
	Array [3]
	Weather string
	Enum:
	Array [5]
	Traffic string
	Enum:
	Array [3]
	}
	transport_mode Transport_Mode string
	Enum:
	Array [4]
	ranking number($float)
	}

22	**User_Quality_Service_Preferences**{
	user_uuid string($uuid)
	cheap_vs_fast number($float)
	cheap_vs_comfort number($float)
	fast_vs_comfort number($float)
	}

23	**User_Transport_Type_Preferences**{
	user_uuid string($uuid)
	private_vs_public number($float)
	public_vs_shared number($float)
	shared_vs_private number($float)
	}

24	**Carpooling_Trip**{
	user_uuid* string($uuid)
	trip_origin* **Location**{...}
	trip_destination* **Location**{...}
	trip_start_time* string($dateTime)
	}

25	**Notification_Message**{
	user_uuid* string($uuid)
	content* **InfoTextType**{...}
	type string($enumeration)
	start_date string($dateTime)
	end_date string($dateTime)
	area [**Location**{...}]
	}

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26	MaaS_Provider{
	id number($integer)
	maas_provider_uuid* string($uuid)
	description InfoTextType{...}
	name* string
	boundary* [Location{...}]
	provided_services* [string($enumeration)]
	country_code string($enumeration)
	}

27	Contractual_MaaS_Provider{
	provider_uuid* string($uuid)
	provider_description InfoTextType{...}
	provider_name* string
	boundary* [Location{...}]
	provided_transport_services* [string($enumeration)]
	country_code string($enumeration)
	support_through_roaming* boolean
	home_maas string($uuid)
	associated_roaming_contract number($integer)
	}

28	InfoTextType{
	language string($enumeration)
	value string
	}

29	Location{
	coordinates string
	latitude number($float)
	longitude number($float)
	altitude number($float)
	precision number($integer)
	}

30	Roaming_Contract{
	roaming_contract_uuid* string($uuid)
	roaming_fee_amount* number($float)
	roaming_fee_currency* string($enumeration)
	contract_start_date string($dateTime)
	contract_end_date string($dateTime)
	is_active* boolean
	home_maas number($integer)
	foreign_maas number($integer)
	}

31	Roaming_Transaction{
	roaming_transaction_uuid* string($uuid)
	charge_amount* number($float)
	charge_currency* string($enumeration)
	transaction_date string($dateTime)
	user_uuid* string($uuid)
	roaming_start_point Location{...}
	roaming_end_point Location{...}
	associated_roaming_contract* number($integer)
	}

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32	**Reservation**{
	reservation_uuid* string($uuid)
	provider* string($enumeration)
	}

33	**Vehicle**{
	vehicle_uuid* string($uuid)
	type* string($enumeration)
	provider* string($enumeration)
	licensePlate* string
	model string
	location **Location**{...}
	Fuel string($enumeration)
	transmission string($enumeration)
	seats number($integer)
	}

34	**Ride**{
	ride_uuid* string($uuid)
	provider* string($enumeration)
	vehicle* **Vehicle**{...}
	provider_phone string
	delay number($integer)
	origin* **Location**{...}
	destination* **Location**{...}
	status* string($enumeration)
	pickup_time string($dateTime)
	dropoff_time string($dateTime)
	seats number($integer)
	}

35	**Ticket**{
	ticket_uuid* string($uuid)
	provider* string($enumeration)
	means [**Vehicle**{...}]
	pnr* string
	barcode string
	purchased_at* string($dateTime)
	validity* number($integer)
	}

36	**Incentive_Point_Currency**{
	point_currency_uuid* string($uuid)
	custom_name* string
	type string($enumeration)
	monetary_value* **Price**{...}
	geographic_area [**Location**{...}]
	start_date string($dateTime)
	end_date string($dateTime)
	}

37	**Incentive_Transaction**{
	incentive_transaction_uuid* string($uuid)
	date string($dateTime)
	type* string
	description string
	points* number($integer)
	associated_to_balance* **Incentive_Balance**{...}
	}

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38	Incentive_Balance{
	incentive_balance_uuid* string($uuid)
	total* number($float)
	currency_type Incentive_Point_Currency{...}
	assignedToUser* User{...}
	last_update string($dateTime)
	}

39	Incentive_Point{
	incentive_point_uuid* string($uuid)
	name* string
	description InfoTextType{...}
	pointCurrency Incentive_Point_Currency{...}
	}

40	Incentive_Rule{
	incentive_rule_uuid* string($uuid)
	name* string
	description InfoTextType{...}
	parameters string
	geographic_area [Location{...}]
	start_date* string($dateTime)
	end_date* string($dateTime)
	}

41	Incentive_Award{
	award_uuid string($uuid)
	name* string
	description InfoTextType{...}
	geographic_area [Location{...}]
	start_date* string($dateTime)
	end_date* string($dateTime)
	monetary_value* Price{...}
	current_availability* number($integer)
	payment_type Incentive_Payment_Type{...}
	}

42	Incentive_Voucher{
	voucher_uuid* string($uuid)
	name* string
	description InfoTextType{...}
	start_date string($dateTime)
	end_date string($dateTime)
	monetary_value* Price{...}
	}

43	Incentive_Payment_Type{
	ipt_uuid* string($uuid)
	allowed_currency* Incentive_Point_Currency{...}
	start_date string($dateTime)
	end_date string($dateTime)
	monetary_tradeoff number($integer)
	}

1	Distance string Enum: Array [3] [SHORT, MEDIUM, LONG]

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2	**Weather** `string` Enum: Array [5] [RAINY, COLD, SUNNY, HOT, WINDY]
3	**Traffic** `string` Enum: Array [3] [LOW, MEDIUM, HIGH]
4	**Context_Type** `string` Enum: Array [5] [distance_mobility_preferences, weather_mobility_preferences, traffic_mobility_preferences]
5	**Transport_Mode** `string` Enum: Array [4] [CAR, BIKE, BUS, TRAIN]

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3 DATA ENTITIES

In general, an entity is an existing or real thing. In programming and engineering, the word is used to identify units, whether concrete things or abstract ideas, that have no ready name or label. A data entity is an object in a data model. Data is typically designed by breaking things down into their smallest parts that are useful for representing data relationships.

3.1 IDENTITY MANAGER DATA ENTITIES

Table 2 User Entity

User Entity						
Property	**Required**	**Data Type**	**Standard/Format**	**Description**	**Example**	**Instances**
id	*	uuid (unique identifier)	ISO/IEC 9834-8:2005	128-bit identifiers that are either guaranteed or have a high probability of being globally unique	456ba254-3676-b673-1387-34ba13a46723	1
phone	-	String	E.164	User's phone number	+491751234578	1

Table 3 Credential Entity

Credential Entity						
Property	**Required**	**Data Type**	**Standard/Format**	**Description**	**Example**	**Instances**
uuid	*	uuid (unique identifier)	ISO/IEC 9834-8:2005	128-bit identifiers that are either guaranteed or have a high probability of being globally unique	456ba254-3676-b673-1387-34ba13a46723	1
user	*	**User** (see table **User**)	-	The user these credentials belong to	See **User table** for indicative values	1

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provider	-	**MaaS Provider** (see table **MaaS Provider**)	-	The provider these credentials are to be used with	See MaaS Provider table for indicative values	1
credentials	-	String	-	Encrypted credentials such as tokens or structures.	eyJzdWIiOiIxMjM0NTY3ODkwIiwibmFtZSI6IkpvaG4	1

3.2 User Tariffs Manager Data Entities

Table 4 Subscription Entity

Subscription Entity						
Property	**Required**	**Data Type**	**Standard/Format**	**Description**	**Example**	**Instances**
uuid	*	uuid (unique identifier)	ISO/IEC 9834-8:2005	128-bit identifiers that are either guaranteed or have a high probability of being globally unique	456ba254-3676-b673-1387-34ba13a46723	1
user	*	**User** (see table **User**)	-	The user this subscription belongs to	See **User** table for indicative values	1
plan	-	**Plan** (see table **Plan**)	-	The plan and pricing schema of this subscription	See **Plan** table for indicative values	1
payment	-	**Payment** (see **Payment**)	-	The payment method to be used to pay for this subscription	See **Payment** table for indicative values	1
recurring_on	-	DateTime	ISO 8601	The date of renewal of this subscription	2018-01-15T21:39:51+00:00	1
created	-	DateTime	ISO 8601	The date of creation of this subscription	2018-01-15T21:39:51+00:00	1

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Table 5 Plan Entity

Plan Entity						
Property	**Required**	**Data Type**	**Standard/Format**	**Description**	**Example**	**Instances**
uuid	*	uuid (unique identifier)	ISO/IEC 9834-8:2005	128-bit identifiers that are either guaranteed or have a high probability of being globally unique	456ba254-3676-b673-1387-34ba13a46723	1
name	*	String	-	A user friendly name for this subscription	Monthly, Quarterly, Corporate	1
price	-	**Price** (see table **Price**)	-	A price defined for this subscription	See Price table for indicative values	1
enabled_providers	-	List [String(Enumeration)]	-	A list of providers which can be queried and booked by this user when using imove	[GTTBUSTURIN, CAR2GO, DRIVENOW]	n
quota	-	**Quota** (see table **Quota**)	-	credits remaining for using mobility services	See Quota table for indicative values	1

Table 6 Quota Entity

Quota Entity						
Property	**Required**	**Data Type**	**Standard/Format**	**Description**	**Example**	**Instances**
sharing_credit	-	**Price** (see table **Price**)	-	The credit the user has for sharing a car (what about sharing bikes, etc.?)	150 EURO	1

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pt_credit	-	**Price** (see table **Price**)	-	the credit the user has for using public transport	54 EURO	1
taxi_credit	-	**Price** (see table **Price**)	-	the credit the user has for getting a taxi	160 EURO	1

Table 7 Payment Entity

Payment Entity						
Property	**Required**	**Data Type**	**Standard/Format**	**Description**	**Example**	**Instances**
payment_uuid	*	uuid (unique identifier)	ISO/IEC 9834-8:2005	128-bit identifiers that are either guaranteed or have a high probability of being globally unique	456ba254-3676-b673-1387-34ba13a46723	1
user	*	**User** (see table **User**)	-	The user this payment method belongs to	See **User** table for indicative values	1
payment_provider	-	String (Enumeration)	-	An enumeration value from a set of known payment providers	stripe, paypal, braintree, unicredit	1
payment_token	-	String	-	The id/token representing a payment method on the payment provider, used to charge the user.	eyJhbGciOiJIUzI1NiIsInR5cCI6IkpXVCJ9	1
payment_type	-	String (Enumeration)	-	An enumeration value from a set of known payment methods	credit_card, bank_account, voucher	1

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3.3 Mobility Tracker Data Entities

Table 8 Place Entity

Place Entity						
Property	**Required**	**Data Type**	**Standard/Format**	**Description**	**Example**	**Instances**
place_uuid	*	uuid (unique identifier)	-	The id of the place.	456ba254-3676-b673-1387-34ba13a46723	1
description	-	**Info Text Type** (See table **Info Text Type**)	-	The description of the place.	"Bus stop." in "eng"	1
periode	-	List [DateTime]	ISO 8601	A list of start date-time and end date-time. The date-time is expressed according to ISO 8601	"2018-01-15T21:39:51+00:00","2018-01-15T21:44:30+00:00"]	2
location	-	**Location** (See table **Location**)	Transmodel	A data structure that explicitly defines the location of the place (The place's centre).	See Location table for indicative values	1

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Table 9 Trip Entity

Trip Entity						
Property	**Required**	**Data Type**	**Standard/Format**	**Description**	**Example**	**Instances**
trip_uuid	*	uuid (unique identifier)	ISO/IEC 9834-8:2005	128-bit identifiers that are either guaranteed or have a high probability of being globally unique	456ba254-3676-b673-1387-34ba13a46723	1
trip_origin	*	**Location** (See table **Location**)	Transmodel	The location where the trip started from.	See **Location** table for indicative values	1
trip_destination	*	**Location** (See table **Location**)	Transmodel	The location where the trip ended.	See **Location** table for indicative values	1
user_uuid	-	uuid (unique identifier)	ISO/IEC 9834-8:2005	128-bit identifiers that are either guaranteed or have a high probability of being globally unique	456ba254-3676-b673-1387-34ba13a46723	1
legs	-	List [**Leg**] (See table **Leg**)	-	A list of the different legs of the trip and their respective transportation modes.	See **Leg** table for indicative values	n
price	-	**Price** (see table **Price**)	-	The cost of the trip	See **Price** (table 6) for indicative values	1

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Table 10 Ranked Trip Entity

Ranked Trip Entity						
Property	**Required**	**Data Type**	**Standard/Format**	**Description**	**Example**	**Instances**
trip	-	**Trip** (see table **Trip**)	-	The trip details	See **Trip** table for indicative values	1
rank	-	Integer	-	The rank of the trip	1, 2, 3	1

Table 11 Alternative Trip Entity

Alternative Trip Entity						
Property	**Required**	**Data Type**	**Standard/Format**	**Description**	**Example**	**Instances**
trips	-	List [**Trip** (see table **Trip**)]	-	The trips details	See **Trip** table for indicative values	1
by_CT	-	boolean	-	Choice of trips	1,0	1
by_QoS	-	boolean	-	Choice of trips	1,0	1
by_TT	-	boolean	-	Choice of trips	1,0	1
weather	-	String (Enumeration)	-	Weather Conditions	{"RAINY", "SUNNY": "COLD","HOT"}	1
traffic	-	String (Enumeration)	-	Traffic conditions	{"HIGH","MEDIUM","LOW"}	1

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Table 12 Ranked Transport Mode Entity

Ranked Transport Mode Entity						
Property	**Required**	**Data Type**	**Standard/Format**	**Description**	**Example**	**Instances**
transport_mode	-	String	-	The transport mode	{"CAR", "TRAIN", "CARPOOLING", "BIKE", "CARSHARING"}	1
rank	-	Integer	-	The rank of the trip	1, 2, 3	1

Table 13 Leg Entity

Leg Entity						
Property	**Required**	**Data Type**	**Standard/Format**	**Description**	**Example**	**Instances**
leg_origin	-	**Location** (See table **Location**)	Transmodel	The origin of the leg in Location format	See **Location** table for indicative values	1
leg_destination	-	**Location** (See table **Location**)	Transmodel	The destination of the leg in Location format	See **Location** table for indicative values	1
leg_start_time	-	DateTime	ISO 8601	The start date-time, expressed as defined by ISO8601	2018-01-15T21:39:51+00:00	1
leg_end_time	-	DateTime	ISO 8601	The end date-time, expressed as the defined by ISO 8601	2018-01-15T21:39:51+00:00	1
mode_of_transport	-	String (Enumeration)	-	An enumeration value from a set of mode of transport.	"BUS"	1
transport_provider	-	String (Enumeration)	-	An enumeration value from a set of transport providers.	"GTTBUSTURIN"	1

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user_uuid	-	uuid (unique identifier)	ISO/IEC 9834-8:2005	128-bit identifiers that are either guaranteed or have a high probability of being globally unique	456ba254-3676-b673-1387-34ba13a46723	1
price	-	**Price** (see table **Price**)	-	The cost of the leg	see table **Price** for indicative values	1

Table 14 Weekly Schedule Entity

Weekly Schedule Entity						
Property	**Required**	**Data Type**	**Standard/Format**	**Description**	**Example**	**Instances**
week_day	-	Integer (Enumeration)	Integer	Day of the week. Number between 0 (Monday) and 6 (Sunday).	3	1
arrival_time	-	DateTime	ISO 8601	Starting time for this schedule. The time is expressed as the defined by ISO 8601	2018-01-15T21:39:51+00:00	1
departure_time	-	DateTime	ISO 8601	Finishing time for this schedule. The time is expressed as the defined by RFC 3339, section 5.6.	2018-01-15T21:39:51+00:00	1

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Table 15 Monthly Schedule Entity

Monthly Schedule Entity						
Property	**Required**	**Data Type**	**Standard/Format**	**Description**	**Example**	**Instances**
month_day	-	Integer (Enumeration)	Integer	Day of the month. Number between 1 and 31.	1	1
arrival_time	-	DateTime	ISO 8601	Starting time for this schedule. The time is expressed as defined by ISO 8601	2018-01-15T21:39:51+00:00	1
departure_time	-	DateTime	ISO 8601	Finishing time for this schedule. The time is expressed as defined by ISO 8601	2018-01-15T21:39:51+00:00	1

Table 16 Schedule Entity

Schedule Entity						
Property	**Required**	**Data Type**	**Standard/Format**	**Description**	**Example**	**Instances**
weekly	-	List [**Weekly Schedule**] (See table **Weekly Schedule**)	-	List of weekly schedules	[weekly_schedule1, weekly_schedule2, weekly_schedule3]	n
monthly	-	List [**Monthly Schedule**] (See table **Monthly Schedule**)	-	List of monthly schedules	[monthly_scedule1, monthly_schedule2, monthly schedule3]	n

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Table 17 Recurrent Place Entity

Recurrent Place Entity						
Property	**Required**	**Data Type**	**Standard/Format**	**Description**	**Example**	**Instances**
place	-	**Place** (see table **Place**)	-	Description of the place.	See **Place** table for indicative values	1
schedule	-	**Schedule** (see table **Schedule**)	-	Description of the schedule.	See **Schedule** table for indicative values	1

Table 18 Recurrent Trip Entity

Recurrent Trip Entity						
Property	**Required**	**Data Type**	**Standard/Format**	**Description**	**Example**	**Instances**
trip	-	**Trip** (See table **Trip**)	-	Description of the trip.	See **Trip** table for indicative values	1
schedule	-	**Schedule** (See table **Schedule**)	-	Description of the schedule.	See **Schedule** table for indicative values	1

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Table 19 Track Entity

Track Entity						
Property	**Required**	**Data Type**	**Standard/Format**	**Description**	**Example**	**Instances**
location	-	**Location** (see table **Location**)	Transmodel	Location expressed in Transmodel standard. Coordinates (longitude, latitude), altitude and precision may be included	See **Location** entity for indicative values	1
time_stamp	-	DateTime	ISO 8601	The date-time of the location, expressed as defined by ISO 8601	2018-01-15T21:39:51+00:00	1

3.4 Preferences Manager Data Entities

Table 20 User Preferences Entity

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User Preferences Entity						
Property	**Required**	**Data Type**	**Standard/Format**	**Description**	**Example**	**Instances**
user_uuid	*	uuid (unique identifier)	ISO/IEC 9834-8:2005	128-bit identifiers that are either guaranteed or have a high probability of being globally unique	456ba254-3676-b673-1387-34ba13a46723	1
context_mobility_preferences	-	**User_Context_Preferences** (see table **User_Context_Preferences**)	-	The user context preferences	See **User_Context_Preferences** table for indicative values	n
quality_service_preferences	-	**User_Quality_Service_Preferences** (see table **User_Quality_Service_Preferences**)	-	The user quality preferences	See **User_Quality_Service_Preferences** table for indicative values	n
transport_type_preferences	-	**User_Transport_Type_Preferences** (see table **User_Transport_Type_Preferences**)	-	The user transport type preferences	See **User_Transport_Type_Preferences** table for indicative values	n
budget	-	**Price** (see table **Price**)	-	Amount of money that ideally the user would spend in a month	{"amount": 34.5,"currency": "EUR"}	1

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Table 21 User Context Preferences Entity

User Context Preferences Entity						
Property	**Required**	**Data Type**	**Standard/Format**	**Description**	**Example**	**Instances**
user_uuid	*	uuid (unique identifier)	ISO/IEC 9834-8:2005	128-bit identifiers that are either guaranteed or have a high probability of being globally unique	456ba254-3676-b673-1387-34ba13a46723	1
context_type	-	String (Enumeration)	-	The user context type preferences categories	[distance_mobility_preferences, weather_mobility_preferences, traffic_mobility_preferences]	1
context_value	-	**One of** String (Enumeration)	-	The context value in terms of distance, weather or traffic	Distance [SHORT, MEDIUM, LONG] Weather [RAINY, COLD, SUNNY, HOT, WINDY] Traffic [LOW, MEDIUM, HIGH]	1
transport_mode	-	String (Enumeration)	-	The preferred transport mode	[CAR, BIKE, BUS, TRAIN]	1
ranking	-	float	-	The context preferences ranking	1.5	1

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Table 22 User Quality Service Preferences Entity

User Quality Service Preferences Entity						
Property	**Required**	**Data Type**	**Standard/Format**	**Description**	**Example**	**Instances**
user_uuid	*	uuid (unique identifier)	ISO/IEC 9834-8:2005	128-bit identifiers that are either guaranteed or have a high probability of being globally unique	456ba254-3676-b673-1387-34ba13a46723	1
cheap_vs_fast	-	float	-	How much more is cheap preferred over fast	1.5	1
cheap_vs_comfort	-	float	-	How much more is cheap preferred over comfort	0.7	1
fast_vs_comfort	-	float	-	How much more is fast preferred over comfort	0.2	1

Table 23 User Transport Type Preferences Entity

User Transport Type Preferences Entity						
Property	**Required**	**Data Type**	**Standard/Format**	**Description**	**Example**	**Instances**
user_uuid	*	uuid (unique identifier)	ISO/IEC 9834-8:2005	128-bit identifiers that are either guaranteed or have a high probability of being globally unique	456ba254-3676-b673-1387-34ba13a46723	1

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private_vs_public	-	float	-	How much more is private preferred over public	1.5	1
public_vs_shared	-	float	-	How much more is public preferred over shared	0.7	1
shared_vs_private	-	float	-	How much more is shared preferred over private	0.2	1

Table 24 Carpooling Trip Entity

Carpooling Trip Entity						
Property	**Required**	**Data Type**	**Standard/Format**	**Description**	**Example**	**Instances**
user_uuid	*	uuid (unique identifier)	ISO/IEC 9834-8:2005	128-bit identifiers that are either guaranteed or have a high probability of being globally unique. This field identifies the user offering the carpooling	456ba254-3676-b673-1387-34ba13a46723	1
trip_origin	*	**Location** (See table **Location**)	Transmodel	place where the trip starts	See **Location** table for indicative values	1
trip_destination	*	**Location** (See table **Location**)	Transmodel	place where the trip ends	See **Location** table for indicative values	1
trip_start_time	*	DateTime	ISO 8601	timestamp indicating when the trip starts	2018-01-15T21:39:51+00:00	1

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3.5 Notification Manager Data Entities

Table 25 Notification Message Entity

Notification Message Entity						
Property	**Required**	**Data Type**	**Standard/Format**	**Description**	**Example**	**Instances**
user_uuid	*	uuid (unique identifier)	ISO/IEC 9834-8:2005	128-bit identifiers that are either guaranteed or have a high probability of being globally unique	456ba254-3676-b673-1387-34ba13a46723	1
content	*	**Info Text Type** (see table **Info Text Type**)	-	The notification message content	"This is an informational notfication" in "eng"	1
type	-	String (Enumeration)	-	The notification message type	"Incentive"	1
start_date	-	DateTime	ISO 8601	Date and Time is expressed in ISO 8601 format, combining date and time in UTC.	2018-01-15T21:39:51+00:00	1
end_date	-	DateTime	ISO 8601	Date and Time is expressed in ISO 8601 format, combining date and time in UTC.	2018-01-15T21:39:51+00:00	1
area	-	List [**Location**] (See table **Location**)	Transmodel	An ordered sequence either of points or of links, defining a path through the network	[location1, location 2, location 3]	n

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3.6 Roaming Manager Data Entities

Table 26 Contractual MaaS Provider Entity

Contractual MaaS Provider Entity						
Property	**Required**	**Data Type**	**Standard/Format**	**Description**	**Example**	**Instances**
provider_uuid	*	uuid (unique identifier)	ISO/IEC 9834-8:2005	128-bit identifiers that are either guaranteed or have a high probability of being globally unique	456ba254-3676-b673-1387-34ba13a46723	1
provider_description	-	**Info Text Type** (See table **Info Text Type**)	-	It specifies the additional info text and the language in which it is provided	"This is a taxi provider" in "eng"	1
provider_name	*	String	String	The name of the Provider	URBI	1
boundary	*	List [**Location**] (See table **Location**)	Transmodel	An ordered sequence either of points or of links, defining a path through the network	[location1, location 2, location 3]	n
provided_transport_services	*	List [**Mode**]	Transmodel	A list of the means of transport provided by the Provider	[taxi, car pooling, bike sharing]	n
country_code	-	String	ISO 3166-1	The country code should be two-letter defined in ISO 3166-1	"GR"	1

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support_through_roaming	*	boolean	-	Value to check if the MaaS provider offers support through roaming	1,0	1
home_maas	-	String uuid (unique identifier)	ISO/IEC 9834-8:2005	128-bit identifiers that are either guaranteed or have a high probability of being globally unique	456ba254-3676-b673-1387-34ba13a46723	1
associated_roaming_contract	-	Integer	-	The number of the associated roaming contract	2	n

Table 27 MaaS Provider Entity

MaaS Provider Entity						
Property	**Required**	**Data Type**	**Standard/Format**	**Description**	**Example**	**Instances**
id	-	Integer	-	The identifier of the MaaS providers list	1	1
maas_provider_uuid	*	uuid (unique identifier)	ISO/IEC 9834-8:2005	128-bit identifiers that are either guaranteed or have a high probability of being globally unique	456ba254-3676-b673-1387-34ba13a46723	1
description	-	**Info Text Type** (See table **Info Text Type**)	-	It specifies the additional info text and the language in which it is provided	"This is a taxi provider" in "eng"	1
name	*	String	-	The name of the Provider	URBI	1

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boundary	*	List [**Location**] (See table **Location**)	Transmodel	An ordered sequence either of points or of links, defining a path through the network	[location1, location 2, location 3]	n
provided_services	*	List [Mode]	Transmodel	A list of the means of transport provided by the Provider	[taxi, car pooling, bike sharing]	n
country_code	-	String	ISO 3166-1	The country code should be two-letter defined in ISO 3166-1	"GR"	1

Table 28 Info Text Type Entity

Info Text Type Entity						
Property	**Required**	**Data Type**	**Standard/Format**	**Description**	**Example**	**Instances**
lang	-	LanguageCodeType	ISO-639	The language in which the additional info text is provided. Language code as per ISO-639	"eng", "de", etc.	1
value	-	String	-	The additional info text	"This is some text"	1

Table 29 Location Entity

Location Entity						
Property	**Required**	**Data Type**	**Standard/Format**	**Description**	**Example**	**Instances**
coordinates	-	String	Google standard	Pair of coordinates in google standard	47.662249 9.360922	n

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latitude	-	float number DD.dddddd Signed degrees format (Latitude ranges from -90 to 90) Precede South latitude with a minus sign	WGS84	Latitude of location	-74,424655	1
longitude	-	float number DDD.dddddd Signed degrees format (Longitude ranges from -180 to 180) Precede West longitude with a minus sign	WGS84	Longitude of Location	12,654567	1
altitude	-	float number DDD.dddddd Signed degrees format	EGM96 geoid model	Meters above mean sea level as defined by the EGM96 geoid model	123,2	1
precision	-	Integer	-	Refers to the number of digits that are present in the coordinates of the location data type. For instance the precision of longitude's value 12.654567 is 8	5	1

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Table 30 Roaming Transaction Entity

Roaming Transaction Entity						
Property	**Required**	**Data Type**	**Standard/Format**	**Description**	**Example**	**Instances**
roaming_transaction_uuid	*	uuid (unique identifier)	ISO/IEC 9834-8:2005	128-bit identifiers that are either guaranteed or have a high probability of being globally unique for each roaming transaction	456ba254-3676-b673-1387-34ba13a46723	1
roaming_transaction_price	*	**Price** (See table **Price**)	-	Price of roaming services containing information about the currency (string) and the amount (float)	See **Price** Table for indicative price data type indicative values	1
roaming_transaction_date	-	DateTime	ISO 8601	Date and Time is expressed in ISO 8601 format, combining date and time in UTC.	2018-01-15T21:39:51+00:00	1
user_uuid	*	uuid (unique identifier)	ISO/IEC 9834-8:2005	128-bit identifiers that are either guaranteed or have a high probability of being globally unique for each user	456ba254-3676-b673-1387-34ba13a46723	1
roaming_start_point	-	**Location** (See table **Location**)	Transmodel	Starting point with respect to roaming service	See **Location** table for indicative values	1
roaming_end point	-	**Location** (See table **Location**)	Transmodel	Ending point with respect to roaming service	See **Location** table for indicative values	1

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associated_roaming_contract	*	Integer	-	The number for the associated roaming contract	1	1

Table 31 Roaming Contract Entity

Roaming Contract Entity						
Property	**Required**	**Data Type**	**Standard/Format**	**Description**	**Example**	**Instances**
roaming_contract_uuid	*	uuid (unique identifier)	ISO/IEC 9834-8:2005	128-bit identifiers that are either guaranteed or have a high probability of being globally unique for each roaming contract	456ba254-3676-b673-1387-34ba13a46723	1
roaming_fee_amount	*	float	-	The roaming fee amount	114.5	1
roaming_fee_currency	*	String	-	The currency of the roaming fee	EUR	1
contract_start_date	-	DateTime	ISO 8601	Date and Time is expressed in ISO 8601 format, combining date and time in UTC.	2018-01-15T21:39:51+00:00	1
contract_end_date	-	DateTime	ISO 8601	Date and Time is expressed in ISO 8601 format, combining date and time in UTC.	2018-01-15T21:39:51+00:00	1
is_active	*	boolean	-	A boolean value indicating whether the	true/false	1

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				roaming contract is active		
home_maas	-	uuid (unique identifier)	ISO/IEC 9834-8:2005	128-bit identifiers that are either guaranteed or have a high probability of being globally unique for each MaaS Provider	456ba254-3676-b673-1387-34ba13a46723	1
foreign maas	-	uuid (unique identifier)	ISO/IEC 9834-8:2005	128-bit identifiers that are either guaranteed or have a high probability of being globally unique for each MaaS Provider	326ba834-3676-aa73-1387-34ba13a46422	n

Table 32 Price Entity

Price Entity						
Property	**Required**	**Data Type**	**Standard/Format**	**Description**	**Example**	**Instances**
amount	-	Float	-	The amount of the price	110,32	1
currency	-	String	ISO 4217	The currency name should be included in the list of active codes as defined in the official ISO 4217 currency names	EURO, CHF, CAD, GBP, etc.	1

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3.7 Price Manager Data Entities

Table 33 Price Entity (previously used in Roaming Manager)

Price Entity (previously used in Roaming Manager)						
Property	**Required**	**Data Type**	**Standard/Format**	**Description**	**Example**	**Instances**
amount	-	Float	-	The amount of the price	110,32	1
currency	-	String	ISO 4217	The currency name should be included in the list of active codes as defined in the official ISO 4217 currency names	EURO, CHF, CAD, GBP, etc.	1

Table 34 Trip Entity (previously used in Mobility Tracker)

Trip Entity (previously used in Mobility Tracker)						
Property	**Required**	**Data Type**	**Standard/Format**	**Description**	**Example**	**Instances**
trip_uuid	*	uuid (unique identifier)	ISO/IEC 9834-8:2005	128-bit identifiers that are either guaranteed or have a high probability of being globally unique	456ba254-3676-b673-1387-34ba13a46723	1
trip_origin	*	**Location** (See table **Location**)	Transmodel	The location where the trip started from.	See **Location** table for indicative values	1

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trip_destination	*	**Location** (See table **Location**)	Transmodel	The location where the trip ended.	See **Location** table for indicative values	1
user_uuid	-	uuid (unique identifier)	ISO/IEC 9834-8:2005	128-bit identifiers that are either guaranteed or have a high probability of being globally unique	456ba254-3676-b673-1387-34ba13a46723	1
legs	-	List [**Leg**] (See table **Leg**)	-	A list of the different legs of the trip and their respective transportation modes.	See **Leg** table for indicative values	n
price	-	**Price** (see table **Price**)	-	The cost of the trip	See **Price** (table 6) for indicative values	1

Table 35 Leg Entity (previously used in Mobility Tracker)

Leg Entity (previously used in Mobility Tracker)						
Property	**Required**	**Data Type**	**Standard/Format**	**Description**	**Example**	**Instances**
leg_origin	-	**Location** (See table **Location**)	Transmodel	The origin of the leg in Location format	See **Location** table for indicative values	1
leg_destination	-	**Location** (See table **Location**)	Transmodel	The destination of the leg in Location format	See **Location** table for indicative values	1
leg_start_time	-	DateTime	ISO 8601	The start date-time, expressed as defined by ISO8601	2018-01-15T21:39:51+00:00	1
leg_end_time	-	DateTime	ISO 8601	The end date-time, expressed as the defined by ISO 8601	2018-01-15T21:39:51+00:00	1

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mode_of_transport	-	String (Enumeration)	-	An enumeration value from a set of mode of transport.	"BUS"	1
transport_provider	-	String (Enumeration)	-	An enumeration value from a set of transport providers.	"GTTBUSTURIN"	1
user_uuid	-	uuid (unique identifier)	ISO/IEC 9834-8:2005	128-bit identifiers that are either guaranteed or have a high probability of being globally unique	456ba254-3676-b673-1387-34ba13a46723	1
price	-	**Price** (see table **Price**)	-	The cost of the leg	see table **Price** for indicative values	1

3.8 Mobility Organizer Data Entities

Table 36 User Entity (previously used in Identity Manager)

User Entity (previously used in Identity Manager)						
Property	**Required**	**Data Type**	**Standard/Format**	**Description**	**Example**	**Instances**
id	*	uuid (unique identifier)	ISO/IEC 9834-8:2005	128-bit identifiers that are either guaranteed or have a high probability of being globally unique	456ba254-3676-b673-1387-34ba13a46723	1
phone	-	String	E.164	User's phone number	+491751234578	1

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Table 37 Subscription Entity (previously used in User Tariffs Manager)

Subscription Entity (previously used in User Tariffs Manager)						
Property	**Required**	**Data Type**	**Standard/Format**	**Description**	**Example**	**Instances**
uuid	*	uuid (unique identifier)	ISO/IEC 9834-8:2005	128-bit identifiers that are either guaranteed or have a high probability of being globally unique	456ba254-3676-b673-1387-34ba13a46723	1
user	*	**User** (see table **User**)	-	The user this subscription belongs to	See **User** table for indicative values	1
plan	-	**Plan** (see table **Plan**)	-	The plan and pricing schema of this subscription	See **Plan** table for indicative values	1
payment	-	**Payment** (see **Payment**)	-	The payment method to be used to pay for this subscription	See **Payment** table for indicative values	1
recurring_on	-	DateTime	ISO 8601	The date of renewal of this subscription	2018-01-15T21:39:51+00:00	1
created	-	DateTime	ISO 8601	The date of creation of this subscription	2018-01-15T21:39:51+00:00	1

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Table 38 MaaS Provider Entity (previously used in Roaming Manager)

MaaS Provider Entity (previously used in Roaming Manager)						
Property	**Required**	**Data Type**	**Standard/Format**	**Description**	**Example**	**Instances**
provider_uuid	*	uuid (unique identifier)	ISO/IEC 9834-8:2005	128-bit identifiers that are either guaranteed or have a high probability of being globally unique	456ba254-3676-b673-1387-34ba13a46723	1
provider_description	-	**Info Text Type** (See table **Info Text Type**)	-	It specifies the additional info text and the language in which it is provided	"This is a taxi provider" in "eng"	1
provider_name	*	String	String	The name of the Provider	URBI	1
boundary	*	List [**Location**] (See table **Location**)	Transmodel	An ordered sequence either of points or of links, defining a path through the network	[location1, location 2, location 3]	n
provided_transport_services	*	List [Mode]	Transmodel	A list of the means of transport provided by the Provider	[taxi, car pooling, bike sharing]	n
country_code	-	String	ISO 3166-1	The country code should be two-letter defined in ISO 3166-1	"GR"	1

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Table 39 User Preferences Entity (previously used in Preferences Manager)

User Preferences Entity (previously used in Preferences Manager)						
Property	**Required**	**Data Type**	**Standard/Format**	**Description**	**Example**	**Instances**
user_uuid	*	uuid (unique identifier)	ISO/IEC 9834-8:2005	128-bit identifiers that are either guaranteed or have a high probability of being globally unique	456ba254-3676-b673-1387-34ba13a46723	1
context_mobility_preferences	-	**User_Context_Preferences** (see table **User_Context_Preferences**)	-	The user context preferences	See **User_Context_Preferences** table for indicative values	n
quality_service_preferences	-	**User_Quality_Service_Preferences** (see table **User_Quality_Service_Preferences**)	-	The user quality preferences	See **User_Quality_Service_Preferences** table for indicative values	n
transport_type_preferences	-	**User_Transport_Type_Preferences** (see table **User_Transport_Type_Preferences**)	-	The user transport type preferences	See **User_Transport_Type_Preferences** table for indicative values	n
budget	-	**Price** (see table **Price**)	-	Amount of money that ideally the user would spend in a month	{"amount": 34.5,"currency": "EUR"}	1

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3.9 Booking Manager Data Entities

Table 40 Reservation Entity

Reservation Entity						
Property	**Required**	**Data Type**	**Standard/Format**	**Description**	**Example**	**Instances**
reservation_uuid	*	uuid (unique identifier)	ISO/IEC 9834-8:2005	128-bit identifiers that are either guaranteed or have a high probability of being globally unique	456ba254-3676-b673-1387-34ba13a46723	1
provider	*	String (Enumeration)	-	An enumeration value from a set of known providers	car2go, drivenow, coup	1

Table 41 Vehicle Entity

Vehicle Entity						
Property	**Required**	**Data Type**	**Standard/Format**	**Description**	**Example**	**Instances**
vehicle_uuid	*	uuid (unique identifier)	ISO/IEC 9834-8:2005	128-bit identifiers that are either guaranteed or have a high probability of being globally unique	456ba254-3676-b673-1387-34ba13a46723	1
type	*	String (Enumeration)	-	An enumeration value from a set of known vehicle types	car, scooter, taxi, train, bus, ferry	1
provider	*	String (Enumeration)	-	An enumeration value from a set of known providers	car2go, drivenow, coup	1

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licensePlate	*	String	-	The vehicle's license plate	AB 123 CD	1
model	-	String	-	The vehicle's model/manufacturer	BMW Serie 1	1
location	-	**Location** (See table **Location**)	Transmodel	Where the vehicle currently is	See **Location** table for indicative values	1
fuel	-	String (Enumeration)	-	Fuel type and level	electric, petrol, diesel	1
transmission	-	String (Enumeration)	-	Transmission type	automatic, manual	1
seats	-	Integer	-	Number of passengers for this vehicle	5 seats	1

Table 42 Ride Entity

Ride Entity						
Property	**Required**	**Data Type**	**Standard/Format**	**Description**	**Example**	**Instances**
ride_uuid	*	uuid (unique identifier)	ISO/IEC 9834-8:2005	128-bit identifiers that are either guaranteed or have a high probability of being globally unique	456ba254-3676-b673-1387-34ba13a46723	1
provider	*	String (Enumeration)	-	An enumeration value from a set of known providers	mytaxi, uber, taksihelsinki	1
vehicle	*	**Vehicle** (See table **Vehicle**)	-	A structure representing a Vehicle	See **Vehicle** table for indicative values	1
provider_phone	-	String	E.164	The phone number of the ride supplier	+491751234578	1

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delay	-	Integer	-	How much time before the vehicle arrives at user's location (estimate)	5 minutes	1
origin	*	**Location** (See table **Location**)	Transmodel	The starting point of the trip	See **Location** table for indicative values	1
destination	*	**Location** (See table **Location**)	Transmodel	The arrival point of the trip	See **Location** table for indicative values	1
status	*	String (Enumeration)	-	An enumeration value from a set of known ride statuses	dispatched, on the way, passenger on board, finished	1
pickup_time	-	DateTime	ISO 8601	When the user has been/will be picked up	2018-01-15T21:39:51+00:00	1
dropoff_time	-	DateTime	ISO 8601	When the user has been/will be dropped off	2018-01-15T21:39:51+00:00	1
seats	-	Integer	-	Number of passengers for this vehicle	5 seats	1

Table 43 Ticket Entity

Ticket Entity						
Property	**Required**	**Data Type**	**Standard/Format**	**Description**	**Example**	**Instances**
ticket_uuid	*	uuid (unique identifier)	ISO/IEC 9834-8:2005	128-bit identifiers that are either guaranteed or have a high probability of being globally unique	456ba254-3676-b673-1387-34ba13a46723	1

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provider	*	String (Enumeration)	-	An enumeration value from a set of known providers	bvg, vbb, atm	1
means	-	List [Vehicle] (See table Vehicle)	-	List of vechicles the ticket is valid for	See Vehicle table for indicative values	n
pnr	*	String	-	The purchase code or ticket number	ABC123	1
barcode	-	String	-	Base64 encoded barcode, or url to image	base64;a176bca63f712.....	1
purchased_at	*	DateTime	ISO 8601	Date of purchase of the ticket	2018-01-15T21:39:51+00:00	1
validity	*	Integer	-	Minutes of validity of the ticket	90 minutes	1

3.10 Incentives & Gamification Manager Data Entities

Table 44 Incentive Point Currency Entity

Incentive Point Currency Entity						
Property	**Required**	**Data Type**	**Standard/Format**	**Description**	**Example**	**Instances**
point_currency_id	*	uuid (unique identifier)	ISO/IEC 9834-8:2005	128-bit identifiers that are either guaranteed or have a high probability of being globally unique	456ba254-3676-b673-1387-34ba13a46723	1
custom_name	*	String	-	The point currency name	"BikeSharingPoints"	1

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type	-	String	-	The type of currency (enum value)	"Credits,Tokens"	1
monetary_value	*	**Price** (See table **Price**)	-	Value for money conversion	See **Price** table for indicative values	1
geographic_area	-	List [**Location**] (See table **Location**)	Transmodel	An ordered sequence either of points or of links, defining a path through the network	[location1, location 2, location 3]	n
start_date	-	DateTime	ISO 8601	Date and Time is expressed in ISO 8601 format, combining date and time in UTC.	2018-01-15T21:39:51+00:00	1
end_date	-	DateTime	ISO 8601	Date and Time is expressed in ISO 8601 format, combining date and time in UTC.	2018-01-15T21:39:51+00:00	1

Table 45 Incentive Transaction Entity

Incentive Transaction Entity						
Property	**Required**	**Data Type**	**Standard/Format**	**Description**	**Example**	**Instances**
incentive_ transaction_uuid	*	uuid (unique identifier)	ISO/IEC 9834-8:2005	128-bit identifiers that are either guaranteed or have a high probability of being globally unique	456ba254-3676-b673-1387-34ba13a46723	1

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date	-	DateTime	ISO 8601	Date and Time is expressed in ISO 8601 format, combining date and time in UTC.	2018-01-15T21:39:51+00:00	1
type	*	String	-	The incentive transaction type	Gain, Voucher, Request. AwardRequest, Initialization, Correction, Bonus, Penalty, Other	1
description	-	**Info Text Type** (see table **Info Text Type**)	-	It specifies the additional info text and the language in which it is provided	"This is a taxi provider" in "eng"	1
points	*	integer	-	Point amount for this transaction	250	1
associated_to_balance	*	**Incentive Balance** (see **table Incentive Balance**)	-	The incentive balance	See **IncentiveBalance** table for indicative values	1

Table 46 Incentive Balance Entity

Incentive Balance Entity						
Property	**Required**	**Data Type**	**Standard/Format**	**Description**	**Example**	**Instances**
incentive_balance_uuid	*	uuid (unique identifier)	ISO/IEC 9834-8:2005	128-bit identifiers that are either guaranteed or have a high probability of being globally unique	456ba254-3676-b673-1387-34ba13a46723	1

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total	*	float	-	Current point amount in the balance	333,3	1
currency_type	-	**Incentive Point Currency** (see **table Incentive Point Currency**)	-	Identifier of the point currency for this balance	See IncentivePointCurrency table for indicative values	1
assignedToUser	*	User (see table **User**)	-	Identifier of the balance owner	See **User** table for indicative values	1
last_update	-	DateTime	ISO 8601	Date and Time is expressed in ISO 8601 format, combining date and time in UTC.	2018-01-15T21:39:51+00:00	1

Table 47 Incentive Point Entity

Incentive Point Entity						
Property	**Required**	**Data Type**	**Standard/Format**	**Description**	**Example**	**Instances**
incentive_point_id	*	uuid (unique identifier)	ISO/IEC 9834-8:2005	128-bit identifiers that are either guaranteed or have a high probability of being globally unique	456ba254-3676-b673-1387-34ba13a46723	1
name	*	String	-	The point name	"BikeSharingPoints"	1
description	-	**Info Text Type** (see table **Info Text Type**)	-	It specifies the additional info text and the language in which it is provided	"This is a taxi provider" in "eng"	1

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pointCurrency	-	**Incentive Point Currency** (see table **Incentive Point Currency**)	-	Identifier of the points currency	See **IncentivePointCurrency** table for indicative values	1

Table 48 Incentive Rule Entity

Incentive Rule Entity						
Property	**Required**	**Data Type**	**Standard/Format**	**Description**	**Example**	**Instances**
incentive_rule_uuid	*	uuid (unique identifier)	ISO/IEC 9834-8:2005	128-bit identifiers that are either guaranteed or have a high probability of being globally unique	456ba254-3676-b673-1387-34ba13a46723	1
name	*	String	-	The name of the incentive	"BikeSharingHeavyUse Rule"	1
description	-	**Info Text Type** (see table **Info Text Type**)	-	It specifies the additional info text and the language in which it is provided	"This is a taxi provider" in "eng"	1
parameters	-	String	-	Additional rule parameters	"param1=10"	1
geographic_area	-	List [**Location**] (See table **Location**)	Transmodel	An ordered sequence either of points or of links, defining a path through the network	[location1, location 2, location 3]	n

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start_date	*	DateTime	ISO 8601	Date and Time is expressed in ISO 8601 format, combining date and time in UTC.	2018-01-15T21:39:51+00:00	1
end_date	*	DateTime	ISO 8601	Date and Time is expressed in ISO 8601 format, combining date and time in UTC.	2018-01-15T21:39:51+00:00	1

Table 49 Incentive Award Entity

Incentive Award Entity						
Property	**Required**	**Data Type**	**Standard/Format**	**Description**	**Example**	**Instances**
award_uuid	-	uuid (unique identifier)	ISO/IEC 9834-8:2005	128-bit identifiers that are either guaranteed or have a high probability of being globally unique	456ba254-3676-b673-1387-34ba13a46723	1
name	*	String	-	Name of the award	"Free Public transport ticket"	1
description	-	**Info Text Type** (see table **Info Text Type**)	-	It specifies the additional info text and the language in which it is provided	"This is a taxi provider" in "eng"	1
geographic_area	-	List [**Location**] (See table **Location**)	Transmodel	An ordered sequence either of points or of links, defining a path through the network	[location1, location 2, location 3]	n

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start_date	*	DateTime	ISO 8601	Date and Time is expressed in ISO 8601 format, combining date and time in UTC.	2018-01-15T21:39:51+00:00	1
end_date	*	DateTime	ISO 8601	Date and Time is expressed in ISO 8601 format, combining date and time in UTC.	2018-01-15T21:39:51+00:00	1
monetary_value	*	**Price** (See table **Price**)	-	Value for money conversion	See **Price** table for indicative values	1
current_availability	*	Integer	-	Quantity available of this award	22	1
payment_type	-	**Incentive Payment Type** (see table **Incentive Payment Type**)	-	List of payment types for this award	See **IncentivePaymentType** table for indicative values	1

Table 50 Incentive Voucher Entity

Incentive Voucher Entity						
Property	**Required**	**Data Type**	**Standard/Format**	**Description**	**Example**	**Instances**
voucher_uuid	*	uuid (unique identifier)	ISO/IEC 9834-8:2005	128-bit identifiers that are either guaranteed or have a high probability of being globally unique	456ba254-3676-b673-1387-34ba13a46723	1
name	*	String	-	Name of the voucher	"Free Public transport ticket"	1

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description	-	**Info Text Type** (see table **Info Text Type**)	-	It specifies the additional info text and the language in which it is provided	"This is a taxi provider" in "eng"	1
start_date	-	DateTime	ISO 8601	Date and Time is expressed in ISO 8601 format, combining date and time in UTC.	2018-01-15T21:39:51+00:00	n
end_date	-	DateTime	ISO 8601	Date and Time is expressed in ISO 8601 format, combining date and time in UTC.	2018-01-15T21:39:51+00:00	1
monetary_value	*	**Price** (See table **Price**)	-	Value for money conversion	See **Price** table for indicative values	1

Table 51 Incentive Payment Type Entity

Incentive Payment Type Entity						
Property	**Required**	**Data Type**	**Standard/Format**	**Description**	**Example**	**Instances**
ipt_uuid	*	uuid (unique identifier)	ISO/IEC 9834-8:2005	128-bit identifiers that are either guaranteed or have a high probability of being globally unique	456ba254-3676-b673-1387-34ba13a46723	1

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allowed_currency	*	**Incentive Point Currency** (see table **Incentive Point Currency**)	-	The currency of the incentive payment	See **IncentivePointCurrency** table for indicative values	1
start_date	-	DateTime	ISO 8601	Date and Time is expressed in ISO 8601 format, combining date and time in UTC.	2018-01-15T21:39:51+00:00	1
end_date	-	DateTime	ISO 8601	Date and Time is expressed in ISO 8601 format, combining date and time in UTC.	2018-01-15T21:39:51+00:00	1
monetary_tradeoff	-	Integer	-	Conversion percentage between currency and monetary value	100	1

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4 REFERENCE INFORMATION MODEL

The definition of Reference Information Model has been the cornerstone of the IMOVE development process. The object model was created by following model-driven methodology. The Reference Data Model (or expressed as Reference Information model) represents the IMOVE's data entities that are used by the software enablers, the data structure of IMOVE elements, and their relationships. Apart from the data entities it also presents; the attributes involved, the logical inter-relationships and data flow between them. Hence ensuring the flow of information into the IMOVE ecosystem.

The model is the combined consensus view of information from the perspective of IMOVE platform and the IMOVE affiliates, which makes it a suitable source for anyone interested to use and interconnect with IMOVE's standards to withdraw their information-related content. The pictorial representation of the model acts like a map which, along with Data Types/Entities are the foundation for all information modelling within IMOVE. The constrained models derived from these serve as documents, data for services, and messages.

IMOVE's Reference Information Model (RIM), is a static model constructed to support the scalability of MaaS and offers useful information as viewed within the scope of IMOVE's standards development activities. The RIM is essential to IMOVE's ongoing mission of increasing precision of data.

4.1 DATA MODEL DIAGRAM VIEW

In this section, we demonstrate the finalized IMOVE reference data model as a pictorial representation. The tool used to create the pictorial representation of the data entities and their relationships was dbdiagram.io. Designed for developers, DBA, data analysts the tool focuses exclusively on drawing database relationship diagrams. The data model is vast in size and therefore the picture presented is not easily printable. The representation is also broken down in the Annexes section, on Annex 1.

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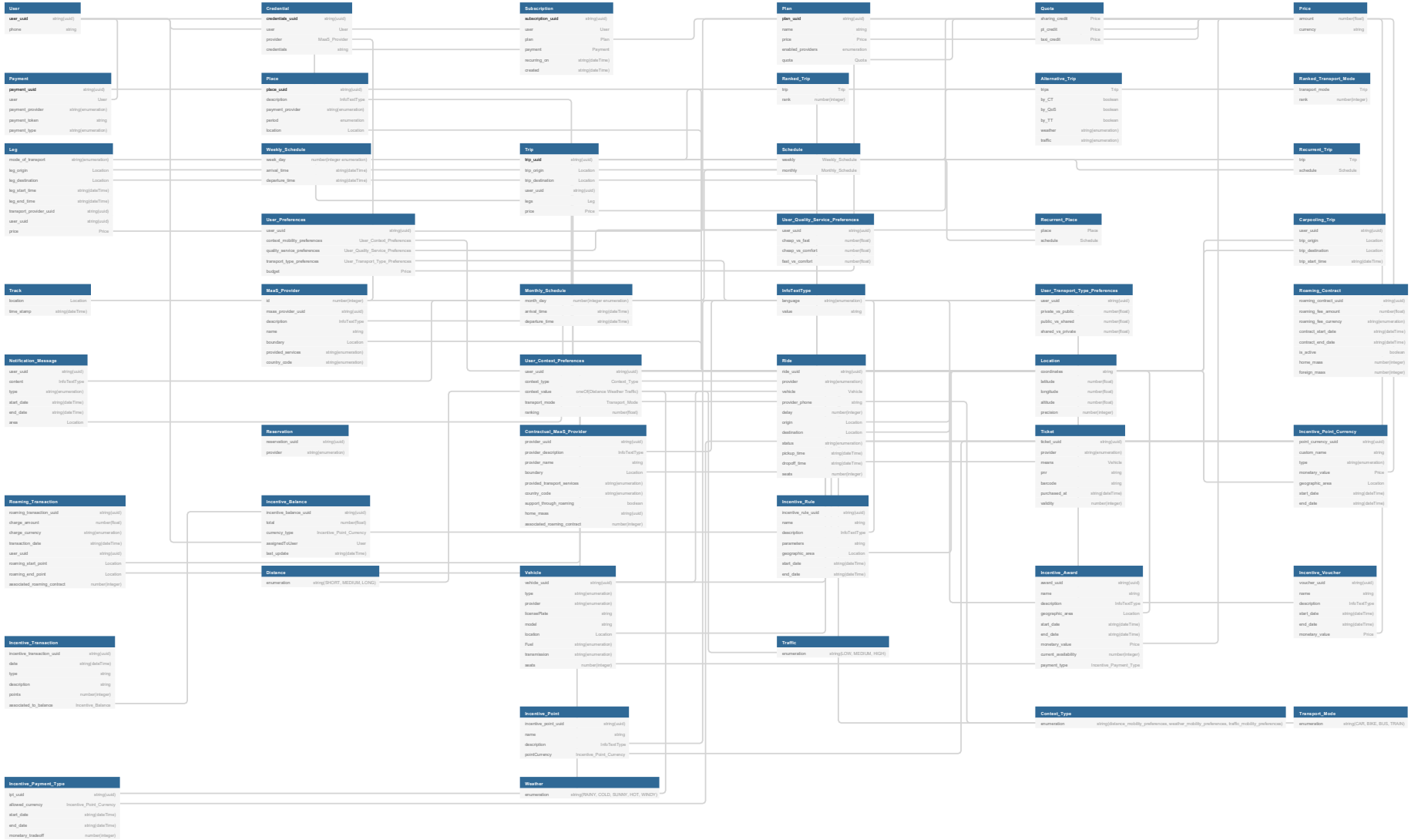

Figure 9 IMOVE Reference Data Model

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5 DATA TRANSLATORS

The Reference Data Model which has been presented in the previous section describes in a structured way all data that are flowing through the IMOVE ecosystem. Existing standards have been proposed and adopted to support compliance with other (external) systems. An IMOVE overview schema has been proposed and finalized based on the various entities and attributes utilized by the software blocks. In this section the data translators are presented, which are supplementary to the enablers' software blocks.

Even if effort has been made in order for IMOVE data model to become interoperable with other MaaS schemes, this is not possible. On the one hand there is lack in existence of published, generally accepted technical standards that are relevant to MaaS solutions, and on the other, due to the innovative approach of IMOVE project which addresses several aspects of the ITS domain, spanning from journey planners to roaming solutions, the design of IMOVE schema, even if it is based on certain ITS entities, cannot be considered to be fully interoperable. IMOVE also is required to bond with existing (previously built) systems that are by nature not interoperable with each other. Future systems hopefully will adopt a globally MaaS standardized data model. For these reasons, the data translation mechanisms were mandatory for converting data from the form used by one system into the form required by another. They take incoming data (from external platforms) and convert it from the incoming format imposed by sources into formats recognizable to IMOVE and vice versa. Data that is sent to or received from legacy applications is often platform-specific information. The translated data are usually described in an XML file, the standard for exchanging information between applications.

Since external platforms are interconnected in IMOVE, data translators play a great role. Adapters, also called data translators, that were implemented in the context of IMOVE according to the needs of the Living Labs' existing MaaS platforms have a dual role: At first, they transform messages between platform specific data models and the IMOVE platform so that they ensure a stable and understandable communication between the two interconnected parties, secondly if needed, modify them, so that IMOVE is compliant with the security and privacy standards that the ERB has set. Security and privacy matters, actually highly concerned service providers who are willing to participate on IMOVE but hesitated to offer their services for security purposes and the application of GDPR. Adapters facilitated the mediation of communication for both consumers and providers with the IMOVE platform. Figure 10 below illustrates the position of the data adapter (field adapter) in the overview of the IMOVE solution.

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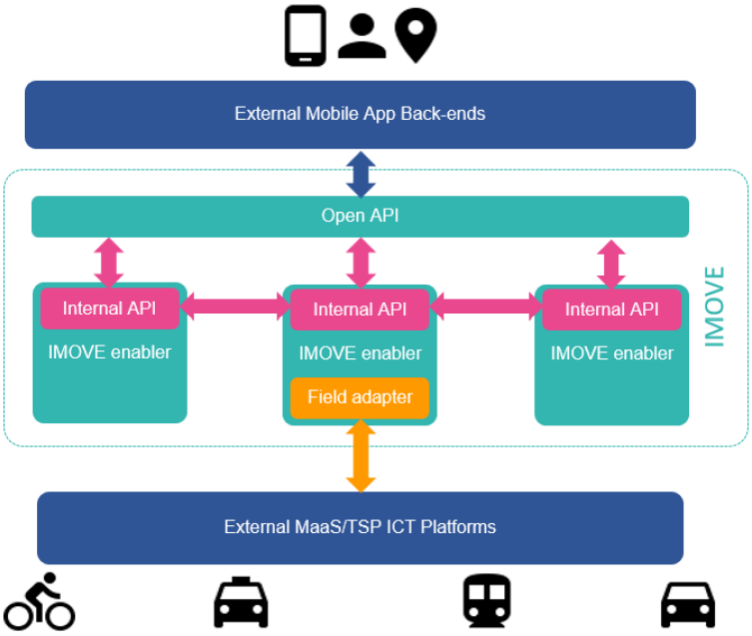

Figure 10 IMOVE Software enablers' field adapters

5.1 Data Translators

The interoperability challenges risen, lead on the design and development of the aforementioned data adapters. A number of pertinent interfaces and software components (data translators) between IMOVE and different MaaS schemes. Their role is to harmonize the data inputs received from the MaaS systems that are active in the Living Labs and adapt them properly to suit the data format requirements of the software enablers that require them. The design and development of the data adapters was performed with close consideration of the needs and constraints set by the MaaS operators on the Living Labs and their specific data models.

An IMOVE software enabler, in order to be in position to offer the relevant service, must ensure proper communication and data exchange with the underling MaaS platform. The role of the data adapter (deployed together with the software enabler) is to fill this gap of possible inconsistencies in the communication. As a next step, the adapter is configured accordingly, so that this service can be made seamlessly accessible according to IMOVE operational principles. The field adapters are data/service translation plug-ins as part of the relevant IMOVE enablers.

Rather than forcing the adaptation of the MaaS solutions in the sites based on IMOVE requirements which would also be impossible taking into account the effort required to the MaaS operators, the translators manage to resolve any discrepancies attributed to the data model developed by IMOVE and the various MaaS Operators. The need for developing pertinent translators supporting the different deployment scenarios of the sites (e.g. diversity in the mobility services, the existing MaaS initiatives, the business models, etc.) was dictated. Utilizing a set of certain mechanisms, IMOVE managed to effectively integrate the heterogeneous actors, services and platforms by transforming data from the IMOVE reference data model to underlying MaaS and services specific models and vice versa.

Moreover, beyond the needs of the project, the translators ensure the extensibility, scalability, openness and ease of adaptation to different environments and different technologically developed MaaS platforms, which in turn will support the roaming of the user's mobility portfolio across different cities for future exploitation.

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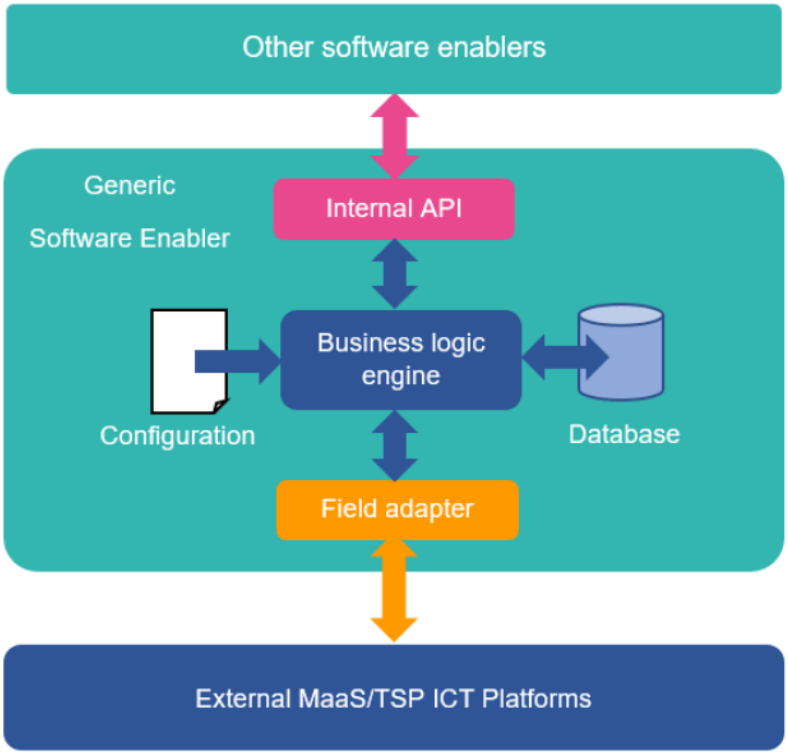

Figure 11 Inside a generic software enabler

No enabler is conceivable as a completely isolated unit, as all of them need some kind of interconnection to other software entities to be of some use:

- Some of the enablers require interoperability with external ICT platforms, controlled by local MaaS providers, to exchange data and services with them
- Many enablers take advantage of functionalities exposed by other enablers to perform their operation

To address the first point, a field adapter encloses a dedicated interface and any required customized logic to interoperate with the external platform. Specific version of these field adapters are developed to interconnect the relevant 3rd party ICT systems, minimizing the development effort required to get the enabler ready to run in a specific IMOVE deployment. This way, the 3rd party ICT systems are in position to consume the data and services provided by IMOVE.

In the following tables, data fields left empty are not subject to data translation but are pieces of information managed internally by relevant software enablers.

5.2 Identity Manager Adapters

The identity manager does not only manage travellers' identifiers and information but acts as a central registry for IMOVE-enabled installations as well. The concept of Domain is central to identify the different deployments of IMOVE-enabled components. Each domain is uniquely identified by a public, readable string, but it's converted internally to a machine-friendly numeric code.

There are concerns regarding the privacy of data at rest. Whenever possible, the use of hashed data is preferred in order to limit the visibility of clear text information in case of a leak.

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Table 52 Identity Manager Adapter

Software enabler's Adapter:	Identity Manager	
Data type	Fed	Converted

User	CheckCredential {
	"domain":"URBI",
	"username":"user01",
	"password":"
	bbf2dead374654cbb32a917afd236656
	",
	"telephone":"+490000000000",
	"commserver":"client.mydomain.com*imove"
	}
		User: {
		“uuid”: “ ”,
		“phone”:
		“595afbc726ea29cc749099e96be27245”
		}
		
		Credential: { “uuid”: “ ”,
		“user”: {
		“uuid”: “ ”,
		“phone”:
		“595afbc726ea29cc749099e96be27245”}
		,
		provider: {“provider_uuid”: “ ”,
		“provider_description”: {
		“uuid”: “ ”,
		“phone”:
		“595afbc726ea29cc749099e96be27245”}
		,
		“provider_name”: “URBI”,
		“boundary”: “ “,
		“provided_transport_
		services”: [],
		“country_code”: “ “}
		“credentials”:
		“be94f3f2aa366d2e19071d4a70939b72”
		}

5.3 User Tariffs Manager Adapters

The User Tariffs manager handles subscriptions and fares, which are usually associated to a cost. In order to avoid rounding and conversion errors, all the prices managed by the software enablers are expressed in cents.

Table 53 User Tariffs manager adapter

Software enabler's Adapter:	User Tariffs Manager	
Data type	Fed	Converted

Taxi Ride - Fare	"ride": {
	"_id": "5a61cf3e3b809f4e936f88d7",
	"time_accepted": "2019-06-19T10:58:25.329Z",
	“time_arriving": "2019-06-19T10:58:35.395Z",
		ride: {
		“ride_uuid”:
		“5a61cf3e3b809f4e936f88d7”,
		“provider”: “wetaxi”,
		“vehicle”: {
		“vehicle_uuid”: “ ”,

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```
   "last_update": "2019-06-19T10:58:07.164Z",
   "dr_amount": 9,
   "fee": 0,
   "full_cost": 9,
   "final_cost": 9,
   "fee_percentage": 0,
   "length": 2812,
   "duration": 293,
   "method": "ON_BOARD",
   "vehicle": {
      "id": "5",
      "tag": "g-998",
      "description": "Toyota Prius",
      "license": "ZZ448ZZ"
   },
   "position": {
      "timestamp": "2019-06-19T08:18:43Z",
      "speed": 23,
      "lat": 45.070668,
      "lng": 7.665689
   }
   "promo": [],
   "passenger": {
      "organizer": "59b2a9d15f63b405704e1060",
      "adult_gen": 4,
      "contact": [],
      "not_in": false
   },
   "flag": {
      "is_flexible": false,
      "is_splittable": false,
      "with_sms": false
   },
   "end_pt": {
      "dest_type": "ADDRESS",
         "coords": [
            7.678657,
            45.063107
        ],
        "address": "Stazione di Porta Nuova, Torino, Italia"
   },
   "start_pt": {
     "dest_type": "ADDRESS",
     "coords": [
        7.665689,
        45.070668
   “type”: “car”,
   “provider”: “wetaxi”,
   “licensePlate”: “ZZ448ZZ”,
   “model”: “Toyota Prius”,
   “location”: {
      “coordinates”: "45.070668  7.665689”,
      “latitude”: 45.070668,
      “longitude”: 7.665689,
      “altitude”:0.000000,
      “precision” : 6
   },
   “fuel”: “ ”,
   “transmission”: “ ”,
   “seats”: 4},
   “provider_phone”: “ “,
   “delay”: “ “,
   “origin”: {
      “coordinates”: “45.070668 7.665689”,
   "latitude": 45.070668,
   "longitude": 7.665689,
   “altitude”:0.000000,
   “precision” : 6},
 “destination”: {
   “coordinates”: “45.063107 7.678657”,
   "latitude": 45.063107,
   "longitude": 7.678657,
   “altitude”:0.000000,
   “precision” : 6},
 “status”: “finished”,
 “pickup_time”: “2019-06-19T10:58:25.329Z”
 “dropoff_time”: “2019-06-19T10:58:35.395Z”,
 “seats”: 4
}
```

	], "taxi_data": "\"\"", "address": "Stazione di Porta Susa, Torino, Italia" }	

Public Transport Ticket - Fare	{
	"MobileTicketId": "MT2CHVJMC",
	"ValidationTimeStamp": "2019-07-07T12:41:22",
	"Duration": 90,
	"Price": 1.5,
	"TariffId": 2095,
	"MaxValidationsAllowed": 1,
	"Description": "Single Urban Ticket",
	"Instruction": "Ticket valid for one journey lasting 90 minutes on the urban networks.",
	"DurationDescription": "90"'
	}
		Ticket {
		“ticket_uuid”: “MT2CHVJMC“,
		“provider”: “GTT”,
		“means”: {
		“vehicle_uuid”: “ ”,
		“type”: “bus”,
		“provider”: “ ”,
		“licensePlate”: “ ”,
		“model”: “ ”,
		“location”: {
		“latitude”: 0.000000,
		“longitude”: 0.000000},
		“Fuel”: “ ”,
		“transmission”: “ ”,
		“seats”: 4},
		“provider_phone”: “ “,
		“delay”: “ “,
		“origin”: {
		“coordinates”: “0.000000 0.000000”,
		"latitude": 0.000000,
		"longitude": 0.000000,
		“altitude”:0.000000,
		“precision” : 6},
		“destination”: {
		“coordinates”: “0.000000 0.000000”,
		"latitude": 0.000000,
		"longitude":0.000000,
		“altitude”:0.000000,
		“precision” : 6},
		“status”: “ ”,
		“pickup_time”: “”
		“dropoff_time”: “”,
		“seats”: “ ”}
		“pnr”: “MT2CHVJMC”,
		“barcode”: “ “,
		“purchased_at”: “2019-07-07T12:41:22“;
		“validity”: 90 }
		
		price": {
		"amount": 1.5,
		"currency": "EUR"
		}

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Shared mobility - Fare	{
	"pricing": {
	"currency": "EUR",
	"parked": 0,
	"driven": 21,
	"vat": 0,
	"total": 411
	},
	"from": {
	"pickup": "Via Cenisio 78, 20154 Milano",
	"coordinates": [
	9.1603049,
	45.4884041
	]
	},
	"to": {
	"coordinates": [
	9.1948542,
	45.473420
	]
	},
	"parked": false,
	"number": 13209,
	"scooterId": "5cb5ec9c1870c6001172655b",
	"closedAt": "2019-05-14T15:39:08.748Z",
	"msParked": 0,
	"msDriven": 1246932,
	"minutesParked": 0,
	"minutesDriven": 21,
	"kilometers": 6,
	"co2": 1.0499999999999998,
	"coins": 1.2,
	"id": "5cdadc3dcfccb6000fb314d8"
	}
		trip: {
		“trip_uuid”: “5cdadc3dcfccb6000fb314d8“
		“trip_origin”: {
		“coordinates”: “45.4884041 9.1603049”,
		"latitude": 45.4884041,
		"longitude": 9.1603049,
		“altitude”: 0.000000,
		“precision”: 7}
		“trip_destination”: {
		“coordinates”: “45.473420 9.1948542”,
		"latitude": 45.473420,
		"longitude": 9.1948542,
		“altitude”: 0.000000,
		“precision”: 7}
		“user_uuid”: " ",
		legs: "elements": [
		{
		"leg_origin": {
		“coordinates”: “45.4884041 9.1603049”,
		"latitude": 45.4884041,
		"longitude": 9.1603049,
		“altitude”:0.000000,
		“precision” : 7,
		},
		"leg_destination": {
		“coordinates”: “45.473420 9.1948542”,
		"latitude": 45.473420,
		"longitude": 9.1948542,
		“altitude”:0.000000,
		“precision” : 7},
		},
		“leg_start_time”: “0000-00-00T00:00:00+00:00”,
		“leg_end_time”: “2019-05-14T15:39:08.748Z”,
		“mode_of_transport”: “scooter”,
		“transport_provider”: “mimoto”,
		“user_uuid”: “ ”,
		“price”: {
		“amount”: "4.1",
		"currency": "EUR"
		}
		}]
		}

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5.4 Mobility Tracker Adapters

The Mobility Tracker component gets user data from External Mobile App Back-ends, this user data is geolocation information such as user tracks obtained by user GPS devices.

The main aim Mobility Tracker has is the user activity and their mobility behavior. Once it has collected the user data from different sources, this enabler treats the acquired data to get additional information as user place and user recurrent places.

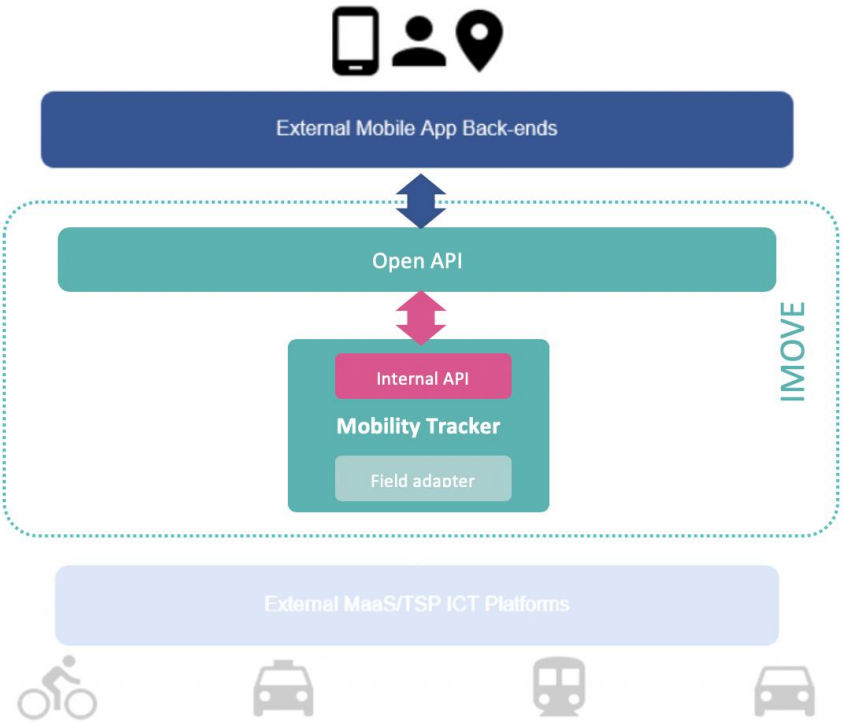

Figure 12 Topology of IMOVE components (enablers, adapters, etc) in Mobility Tracker use case

As shown in the figure above, the Mobility Tracker component is connected with External Mobile App back-ends to get input data through the Open API and the corresponding internal APIs.

In any case, the Mobility Tracker does not use data translators, since it does not need to fetch data directly from any External MaaS/TSP ICT Platform and the reason is because its communication with the other Software Enablers is through the corresponding internal APIs. Therefore, there is no need to create adapters for this Software Enabler.

In addition, the Mobility Tracker software enabler is connected with others Software Enablers such as Preferences Manager to send its results.

5.5 Preferences Manager Adapters

The Preferences Manager component provides mobility information about users. This information ranges from service preferences/options manually selected by the users to service usage patterns automatically inferred

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from their behavior. The user preferences can come from External Mobile App Back-ends and others Software Enablers as Mobility Tracker sends geolocation user information to Preferences Manager.

The main goal of this component is to deduce which are the preferred transport modes of each user under specific circumstances (such as a traffic jam or a rainy day). To do so, the component will collect contextual data and relate it with the information generated by the user profile. Furthermore, this component will get a list of ranking trips regarding context preferences, quality of services preferences and transport type preferences. Finally, Mobility Preferences return all user preference according to their contextual, quality of service and transport type preferences.

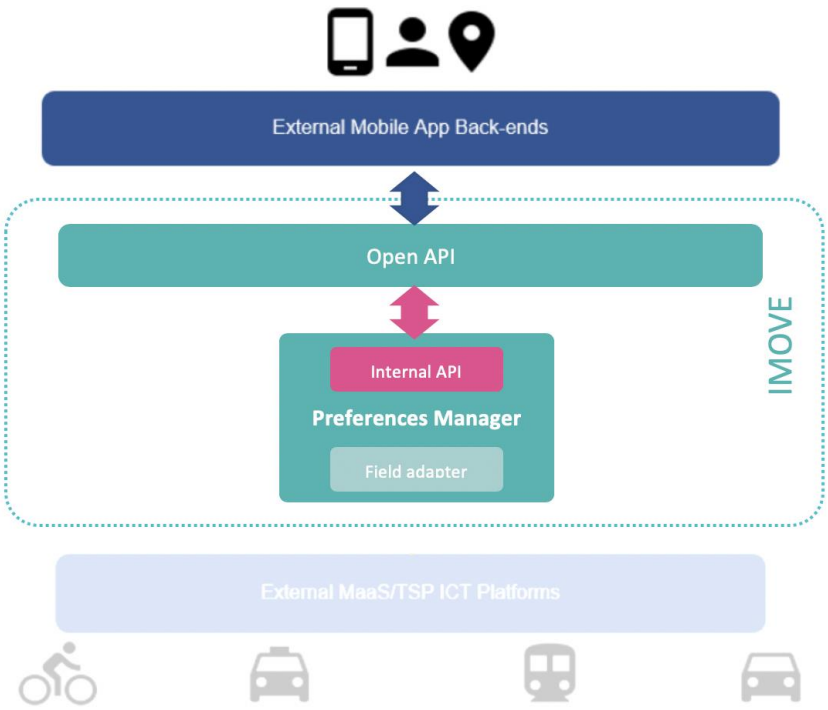

Figure 13 Topology of IMOVE components (enablers, adapters, etc) in Preferences Manager use case

As shown in Figure 13 above, the Preferences Manager component is connected with External Mobile App Back-ends to get input data through the Open API and the corresponding internal APIs. On another hand, the Preferences Manager component does not make use of data translators, because it does not need to fetch data directly from any External MaaS/TSP ICT Platform and because its communication with the other Software Enablers is through the corresponding internal APIs. Therefore, there is no need to create adapters for this Software Enabler. Also, the Preferences Manager software enabler is connected with others Software Enablers such as Mobility Tracker or Mobility Organizer.

5.6 Notification Manager Adapters

The Notification Manager is a software enabler designed to collect and store messages generated by other enablers to be dispatched to IMOVE end users for informational purposes. It features a specific API for this, available to other enablers for input and specifically to the Open API enabler to expose the message retrieval functionality to mobile apps backends. According to the architectural diagram presented in deliverable D2.5,

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no straight connection to external MaaS platforms nor external data sources is foreseen, so data adapters are not required.

5.7 Roaming Manager Adapters

The Roaming Manager is the component which plays a major role in the support of IMOVE use case. More specifically, it enables and ensures the interconnection of multiple MaaS operators enabling for inter-roaming and cross-border roaming services. However, it is worth mentioning that even if the Roaming Manager communicates directly with the other Software Enablers through the corresponding internal APIs, is does not communicate directly with the underlying MaaS platforms.

It is one of the two components (the other is the identity Manager) which has been centrally deployed. Since this Software Enabler does not need to fetch directly data from the LLs, there is no need to create any adaptors for this Software Enabler. This is highlighted in the following figure which presents the topology for the enablers, the adapters and the MaaS Platforms concerning the Roaming use case. As shown, the Roaming and Identity Managers constitute the central and common entities in the Roaming scenario. To this end, these components are not being deployed neither on the visiting (the LL to which the user is subscribed) nor the visited (the LL which offers seamlessly transport services to the foreign user) LL.

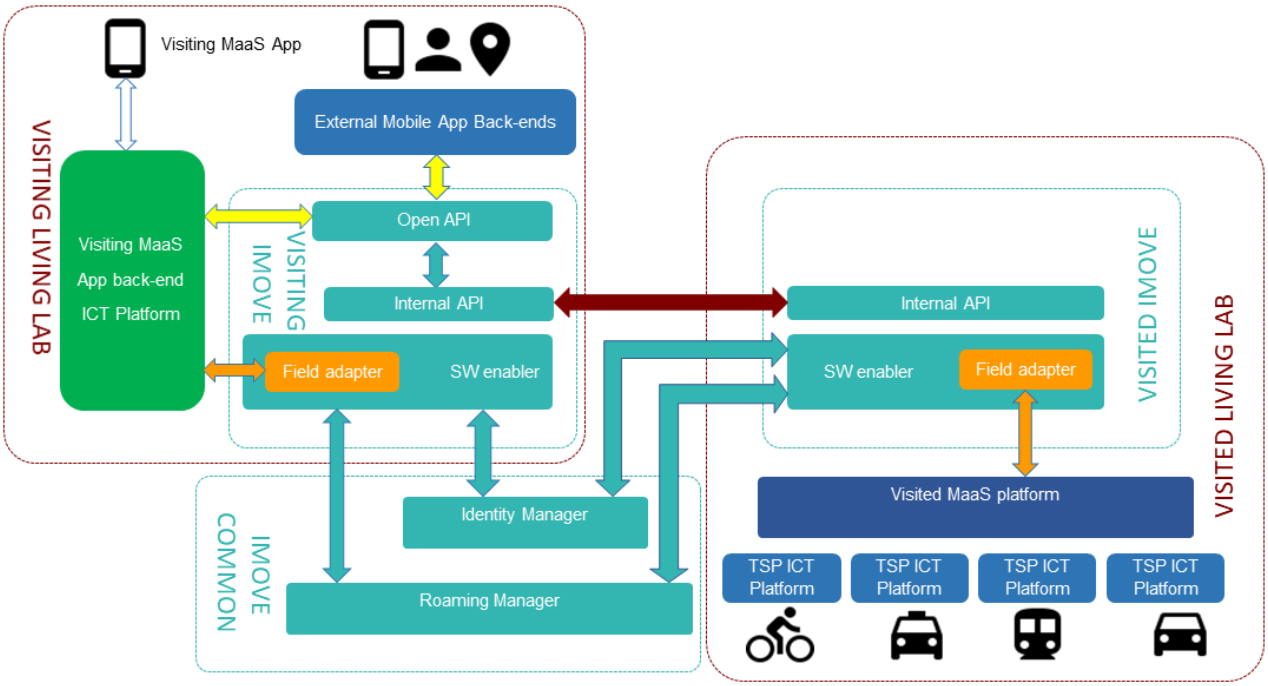

Figure 14 Topology of IMOVE components (enablers, adapters, etc.) in the Roaming use case

On the other hand, as evident in Figure 14, the Roaming Manager communicates directly with the other software enablers (namely the Home Booking Manager and the Home Tariffs manager, all deployed in the Visiting MaaS). Moreover, as shown in the figure, some other Software Enablers make use of Field Adapters in order to access the underlying data of either the visiting MaaS App back-end ICT platform or the visited MaaS platform.

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5.8 PRICE MANAGER ADAPTERS

The *Price Manager* (PM) is the software enabler designed for collecting and/or computing the information about the prices of the services provided by transport operators active in the deployment area.

The Price Manager periodically collects the most up-to-date pricing information from relevant third parties. In addition to this, it can optionally use external entities in the price computation process - for example for estimation of trip distances, durations, or similar data.

The Price Manager is using the following data:

- **OpenStreetMap**: The data from OpenStreetMap is used for two purposes. First, it serves as a map data source for OSRM. Second, the Price Manager can use the count/density of ceratin points of interest around the trip's duration and destination as one of the inputs when estimating the trip price.

The Price Manager implementation comprises the following field adapters:

- **Google Distance Matrix API**: This external API can be used by the Price Manager to compute the trip distance and their estimated duration. This information is used in PM's internal models and trip price computation methods. See Table 54 for more details.
- **OSRM API**: The Open-source Routing Machine is an alternative way to obtain the estimated trip distance and duration. It is used for the same purpose as the Google API but provides certain advantages: Since OSRM can be deployed locally on the same machine/network as PM, it has potential to be much faster. Also, its usage is free. See Table 55 for more details.
- **Uber API**: The Uber API serves simply to obtain estimations of prices by Uber, as well as the estimated pickup times. Instead of the API itself, the PM can use its own internal Uber price model. See the relevant part of the following table for more details.

Table 54 Price Manager adapters

Software enabler's Adapter: Data type	Price manager	
	Fed	Converted to

Google Distance Matrix API to Trip	{
	"destination_addresses": [
	"Berlin-Gesundbrunnen station, Badstraße 1-3, 13357 Berlin, Germany"
	],
	"origin_addresses": [
	"Berlin Südkreuz, Südkreuz, 12101 Berlin, Germany",
	"Pariser Platz, 10117 Berlin, Germany"
	],
	"rows": [
	{
	"elements": [
	{
	"distance": {
	"text": "11.2 km",
	"value": 11191
	},
		trip: {
		“trip_uuid”: “ “
		“trip_origin”: {
		“coordinates”: “52.515869 13.378940”,
		"latitude": 52.515869,
		"longitude": 13.378940,
		“altitude”:0.000000,
		“precision” : 6}
		“trip_destination”: {
		“coordinates”: “52.551590 13.382880”,
		"latitude": 52.551590,
		"longitude": 13.382880,
		“altitude”:0.000000,
		“precision” : 6}
		“user_uuid”: " ",
		legs: "elements": [

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	"duration": {
	"text": "25 mins",
	"value": 1475
	},
	"status": "OK"
	}
	]
	},
	{
	"elements": [
	{
	"distance": {
	"text": "4.5 km",
	"value": 4494
	},
	"duration": {
	"text": "14 mins",
	"value": 856
	},
	"status": "OK"
	}
	]
	}
	],
	"status": "OK"
	}
		{
		"leg_origin": {“coordinates”: “52.515869 13.378940”,
		"latitude": 52.515869,
		"longitude": 13.378940,
		“altitude”:0.000000,
		“precision” : 6},
		},
		"leg_destination": {
		“coordinates”: “52.551590 13.382880”,
		"latitude": 52.551590,
		"longitude": 13.382880,
		“altitude”:0.000000,
		“precision” : 6},
		},
		“leg_start_time”: “0000-00-00T00:00:00+00:00”,
		“leg_end_time”: “0000-00-00T00:00:00+00:00”,
		“mode_of_transport”: “ ”,
		“transport_provider”: “ ”,
		“user_uuid”: “ ”,
		“price”: {
		“amount”: " ",
		"currency": " "
		}
		}]
		}

OSRM API to Leg	{
	"routes": [
	{
	"geometry": {
	"coordinates": [
	[
	13.388798,
	52.517033
	],
	
	...
	
	[
	13.428554,
	52.523239
	]
	],
	"type": "LineString"
	},
	"weight_name": "routability",
	"weight": 1332.6999999999998,
		Leg: {
		"leg_origin": {
		“coordinates”: “52.517033 13.388798”,
		"latitude": 52.517033,
		"longitude": 13.388798,
		“altitude”:0.000000,
		“precision” : 6},
		},
		"leg_destination": {
		“coordinates”: “52.523239 13.428554”,
		"latitude": 52.523239,
		"longitude": 13.428554,
		“altitude”:0.000000,
		“precision” : 6},
		},
		“leg_start_time”: “0000-00-00T00:00:00+00:00”,
		“leg_end_time”: “0000-00-00T00:00:00+00:00”,

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	"duration": 926.7,
	"distance": 4946.799999999999
	}
	],
	"code": "Ok"
	}
		“mode_of_transport”: “ ”,
		“transport_provider”: “ ”,
		“user_uuid”: “ ”,
		“price”: {
		“amount”: " ",
		"currency": " "
		}

Uber API to Price	{
	"localized_display_name": "POOL",
	"distance": 6.17,
	"display_name": "POOL",
	"product_id": "26546650-e557-4a7b-86e7-6a3942445247",
	"high_estimate": 15,
	"low_estimate": 13,
	"duration": 1080,
	"currency_code": "EUR"
	}
		{
		“price”: {
		“amount”: 13.0,
		"currency": "EUR"
		},
		“price”: {
		“amount”: 15.0,
		"currency": "EUR"
		}
		}

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5.9 MOBILITY ORGANIZER ADAPTERS

The *Mobility Organizer* is the software enabler designed to extend the trip planning capabilities towards the needs of a MaaS user and to enable the users to take full advantage of services on offer. In particular, the Mobility Organizer extends the standard trip planning functionalities in the following directions:

- Composing trip itineraries combining public, private and shared means of transport.
- Taking into account mobility service availability and prices, as well as user preferences.

Mobility Organizer is using the following data:

- **Timetables Data:** Timetables data for each LL are loaded in GTFS[1] standard.
- **Park and Ride Positions:** They are used only in Manchester LL using this data[2].

Mobility Organizer is using the following field adapters for the listed APIs:

- **OSRM API:** The Open-source Routing Machine is a locally deployed routing module based on OpenStreetMap data. It is used to quickly find single mode routes for walk, bike, shared-bike, car, and taxi. More details are provided in Table 55.
- **Shared Bikes APIs:** They are used to load positions of shared bikes, positions of bike sharing stations and their status (number of bikes, number of empty slots). The details are listed in the table below; there is one external API used in every LL:
    - Berlin LL: *Nextbike*
    - Manchester LL: *Mobike*
    - Madrid LL: *Citybike*

Table 55 Mobility Organizer adapters

Software enabler's Adapter: Data type	Mobility organizer	
	Fed	Converted to

OSRM API to Leg	{
	"routes": [
	{
	"geometry": {
	"coordinates": [
	[
	13.388798,
	52.517033
	],
	
	...
	
	[
	13.428554,
	52.523239
	]
		Leg: {
		"leg_origin": {
		“coordinates”: “52.517033 13.388798”,
		"latitude": 52.517033,
		"longitude": 13.388798,
		“altitude”:0.000000,
		“precision” : 6},
		},
		"leg_destination": {
		“coordinates”: “52.523239 13.428554”,
		"latitude": 52.523239,
		"longitude": 13.428554,
		“altitude”:0.000000,
		“precision” : 6},
		},
		“leg_start_time”:“0000-00-

[1] https://developers.google.com/transit/gtfs/reference

[2] https://tfgm.com/public-transport/park-and-ride

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	],
	"type": "LineString"
	},
	"weight_name": "routability",
	"weight": 1332.6999999999998,
	"duration": 926.7,
	"distance": 4946.799999999999
	}
	],
	"code": "Ok"
	}
		00T00:00:00+00:00",
		"leg_end_time": "0000-00-00T00:00:00+00:00",
		"mode_of_transport": " ",
		"transport_provider": " ",
		"user_uuid": " ",
		"price": {
		"amount": " ",
		"currency": " "
		}
		}

NextBike shared bike to Vehicle	{
	"uid": 3348687,
	"lat": 52.5311586,
	"lng": 13.4154556,
	"bike": true,
	"name": "BIKE 14585",
	"address": "",
	"spot": false,
	"number": 0,
	"bikes": 1,
	"booked_bikes": 0,
	"bike_racks": 0,
	"free_racks": 0,
	"special_racks": 0,
	"free_special_racks": 0,
	"maintenance": false,
	"terminal_type": ""
	}
		vehicle: {
		"vehicle_uuid": "3348687",
		"type": "bike",
		"provider": "NEXTBIKE",
		"licensePlate": "BIKE 14585",
		"model": " ",
		"location": {
		"coordinates": "52.5311586 13.4154556",
		"latitude": 52.5311586,
		"longitude": 13.4154556
		"altitude":0.0000000,
		"precision" : 7
		}
		"fuel": " ",
		"transmission": " ",
		"seats": " "
		}

Mobike shared bike to Vehicle	"type": "Feature",
	"properties": {
	"name": "A020012975"
	},
	"geometry": {
	"type": "Point",
	"coordinates": [
	-2.255223,
	53.510049
	]
	}
		vehicle {
		"vehicle_uuid": "A020012975",
		"type": "bike",
		"provider": "MOBIKE",
		"licensePlate": " ",
		"model": " ",
		"location": {
		"coordinates": "53.510049 -2.255223",
		"latitude": 53.510049,
		"longitude": -2.255223,
		"altitude":0.000000,
		"precision" : 6
		}
		"fuel": " ",
		"transmission": " ",
		"seats": " "
		}

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CityBike shared bike to Vehicle	"extra": {
	"address": "Calle Pavía no 6",
	"light": "gray",
	"number": "30",
	"uid": 34
	},
	"free_bikes": 1,
	"id": "e4d8fb1acd7ef560cc928425a5c94146",
	"latitude": 40.4192095,
	"longitude": -3.711504,
	"name": "San Quintín",
	"timestamp": "2020-04-03T08:19:20.904000Z"
		vehicle {
		"vehicle_uuid": " e4d8fb1acd7ef560cc928425a5c94146",
		"type": "bike",
		"provider": " CITYBIKE ",
		"licensePlate": "30",
		"model": " ",
		"location": {
		"coordinates": "40.4192095 -3.7115040",
		"latitude": 40.4192095,
		"longitude": -3.7115040,
		"altitude":0.0000000,
		"precision" : 7
		}
		"fuel": " ",
		"transmission": " ",
		"seats": " "
		}

5.10 Booking Manager Adapters

The booking manager handles vehicle reservation, trips information and ticket/fare selling. The data conversion happens between the service provider and the enabler itself.

One of such scenario is represented in the table below, as a blueprint for the many other conversions which are required each time a new provider gets integrated. The conversion necessarily follows a case-by-case basis, unless the providers share a common platform (which is the case in a fair amount of instances).

For instance, here is the conversion that happens between a Miles reservation and an IMOVE reservation representation (only fields which require a conversion, are reported)

Table 56 Booking manager adapter

Software enabler's Adapter:	Booking manager adapter	
Data type	**Fed**	**Converted**
Conditions	"conditions": 0	"weather ": "sunny"

Location	"location": {
	"address":
	"Stargarder Straße, 10437",
	"lat": 50.945438,
	"lon": 6.916111
	}
		"location": {
		"coordinates": "50.945438 6.916111",
		"latitude": 50.945438,
		"longitude": 6.916111,
		"altitude":0.000000,
		"precision" : 6
		}

Price	"pricingTime": "0.99\u20ac\/km", "pricingParking": "69\u20ac\/24h & 100km ",	"price": { "amount": 0.79, "currency": "EUR" },

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		“price”: {
		“amount”: 0.29,
		"currency": "EUR"
		}

Vehicle	{
	"carId": 378,
	"title": "",
	"lat": 50.945438,
	"lon": 6.916111,
	"licencePlate": " B-MI8099",
	"fuelLevel": 27,
	"vehicleStateId": 0,
	"vehicleTypeId": 18,
	"pricingTime": "0.99\u20ac\/km",
	"pricingParking": "69\u20ac\/24h & 100km ",
	"reservationState": 0,
	"address": "Fr\u00f6belstra\u00dfe 15",
	"zipCode": "50823",
	"city": "K\u00f6ln",
	"locationId": 11
	},
		vehicle {
		"vehicle_uuid": "e4d8fb1acd7ef560cc928425a5c94146",
		"type": "car",
		"provider": " driveby",
		"licensePlate": " B-MI8099",
		"model": " ",
		"location": {
		“coordinates”: “50.945438 6.916111”,
		"latitude": 50.945438,
		"longitude": 6.916111,
		“altitude”:0.000000,
		“precision” : 6
		}
		"fuel": {
		"level": 27,
		"type": "petrol"
		},
		"transmission": " ",
		"seats": " "
		}

5.11 Incentives & Gamification Manager Adapters

Incentives & Gamification manager is a software enabler responsible for the implementation of policies and nudging initiatives to promote modal shift, behavioural change and sustainable mobility choices for MaaS customers.

This enabler is somehow peculiar with regard to the data adapters concept, since in principle its data model, developed in the previous sections of this document, comprises a set of data entities (e.g. incentive points, balance, awards, etc.) defined and managed within itself, which typically have no counterpart in external MaaS ICT platforms. However, specific selections of data (possibly but not strictly part of the overall MaaS data model) may be a requisite for the evaluation of the customized business rules defined in individual instances of this component. These pieces of information can be fetched from other enablers whenever feasible, but in some cases they may need to be retrieved through the MaaS platform API or more generally from further external corporate data sources. In situations like these, a field adapter-like component has to be developed to import these records in internal data structures to be processed by the rule engine.

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Table 57 Incentives & Gamification Manager adapter

Software enabler's Adapter:	Incentives & Gamification Manager adapter	
Data type	**Fed**	**Converted**

Location	"tripStart": {
	“address": "Corso Vittorio Emanuele II, Torino",
	"lat": 45.063067,
	"lon": 7.678808
	}
		"location": {
		“coordinates”: “45.063067 7.678808”,
		"latitude": 45.063067,
		"longitude": 7.678808,
		“altitude”:0.000000,
		“precision” :6
		}

	"tripEnd": {
	“address": "Via Santa Chiara 26/F, Torino",
	"lat": 45.075806,
	"lon": 7.679774
	}
		"location": {
		“coordinates”: “45.075806 7.679774”,
		"latitude": 45.075806,
		"longitude": 7.679774,
		“altitude”:0.000000,
		“precision” :6
		}

Date	“date”: “1563787048000”	“date”: “2019-05-15T16:34:51+00:00”

Bike sharing trip to Incentive Transaction	"duration": 1500,
	distance":2.3,
	"type": "bikesharing"
		"incentiveTransaction": {
		“incentive_transaction_uuid”:”86fb8050-cdb7-43aa-ba33-9a55538f60f9”
		“date”: “2019-05-21T18:34:51+00:00”
		“type”: “Gain”
		“description”: {
		“language”: “it”,
		“value”:” “Noleggio Tobike”
		}
		“points”: 6.5
		“incentive_balance_uuid”: ”ce1b1cdc-6e95-4f82-bf2e-496a32dd7cea”
		}

Location	"tripStart ": {
	“address": "Corso Castelfidardo, Torino",
	"lat": 45.063814,
	"lon": 7.659254
	}
		"location": {
		“coordinates”: “45.063814 7.659254”,
		"latitude": 45.063814,
		"longitude": 7.659254,
		“altitude”:0.000000,
		“precision” :6
		}

Location	"tripEnd ": {
	“address": "Corso Luigi Settembrini 211 Torino",
	"lat": 45.030359,
	"lon": 7.615400
	}
		"location": {
		“coordinates”: “45.030359 7.615400”,
		"latitude": 45.030359,
		"longitude": 7.615400
		“altitude”: 0.000000,
		“precision” :6
		}

Date	“date”: “1563189819000”	“date”: “2019-07-15T09:23:39+00:00”

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Taxi ride to Incentive Transaction	"duration": 900,
	“distance":6.1,
	"type": "taxi"
		"incentiveTransaction": {
		“incentive_transaction_uuid”:”86fb8050-cdb7-43aa-ba33-9a55538f60f9”
		“date”: “2019-07-15T09:23:39+00:00”
		“type”: “Gain”
		“description”: {
		“language”: “it”,
		value”:” “Taxi ride”
		}
		“points”: 1.2
		“incentive_balance_uuid”:”ce1b1cdc-6e95-4f82-bf2e-496a32dd7cea”
		}

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CONCLUSIONS

This deliverable is a demonstration of the final outcomes on IMOVE's Reference MaaS Data Model and provides the data modelling specifications for all necessary interfaces among all the IMOVE software enablers so as to connect existing and external services. The major outcome is the definition of the Reference Information Model for use within the IMOVE ecosystem, taking into account the results related to the regulatory framework for MaaS systems. The finalized IMOVE ecosystem contains the software enablers that will be used to build the IMOVE platform.

Following the data modelling steps, the partners worked in close co-operation to define the data entities and their attributes using Swagger and GitLab, so that a complete and stable data model can occur, taking into account the needs and constraints of the Living Labs. The finalized version of the deliverable demonstrates the IMOVE internal ecosystem's data model as a graphical representation and a descriptive complete segmentation of the data entities along with their attributes that software enablers make use of. It is an entity relationship diagram built on UML. It describes in a structured way all data required by MaaS actors, incorporating some existing standards, optionalities, cardinalities and examples.

This second version of the deliverable contains the revision of the data model according to the needs of the project in the development phase following an agile framework. Although the data model is designed to be complete and stable in terms of the software enablers, their interconnection and the services provision towards the external parties, the deployment procedure provides a clearer picture on the actual needs. Since the batches of the enablers were deployed on the pilot living labs, we determined the specific changes and adaptations that should be performed on the data model and the software enablers themselves. Focus is also drawn on the data translators also called data adapters, explaining their importance in the IMOVE ecosystem, the design process and the functionalities they serve.

The final version of this deliverable contains the complete description of all data adapters designed and developed carefully to transform messages between platform specific data models and the IMOVE platform, so as to harmonize the data flows and then manipulate them to suit the data format requirements of each actor that requests them. Throughout this implementation stable and understandable communication was ensured between the interconnected parties, and if needed, modifications of specific data. This enables the IMOVE to be compliant with the security and privacy standards that the ERB has set. That way, services can be made seamlessly accessible according to IMOVE operational principles.

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ANNEXES

ANNEX ONE

In this Annex we present the IMOVE's data model in cropped images in a visible enough print friendly version.

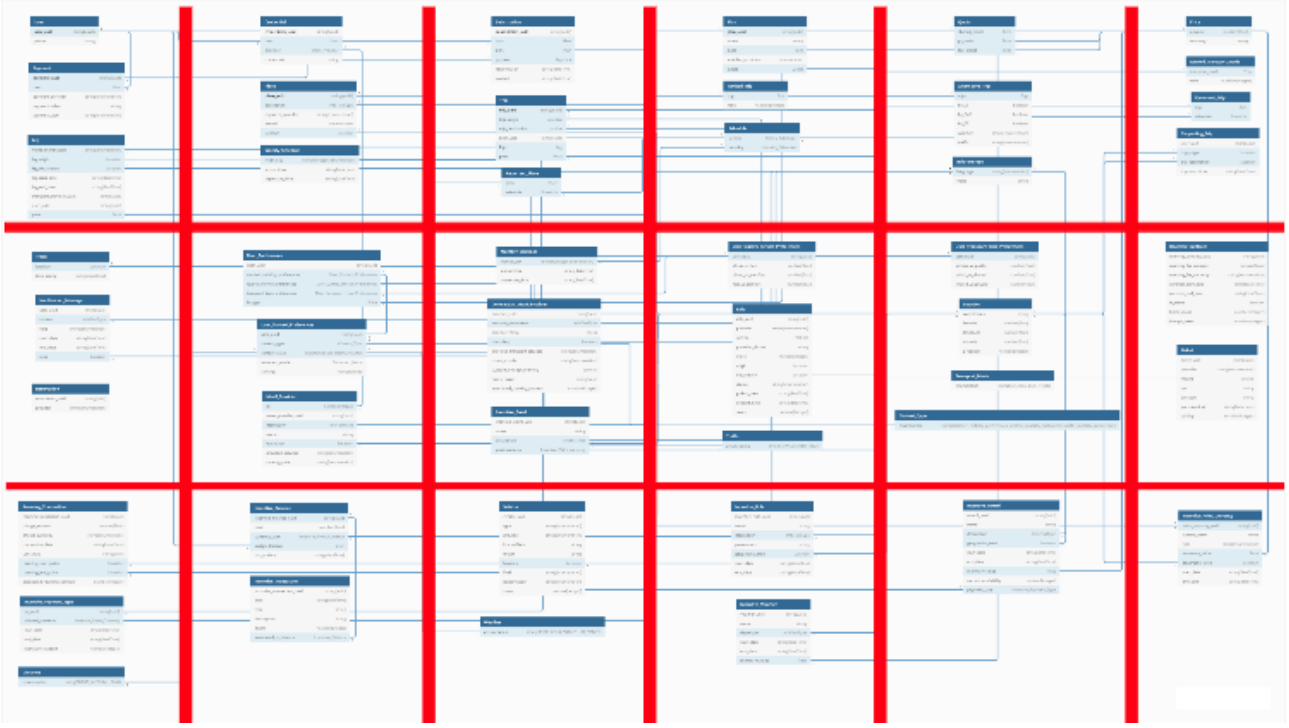

Figure 15 IMOVE Reference Data cropping pattern

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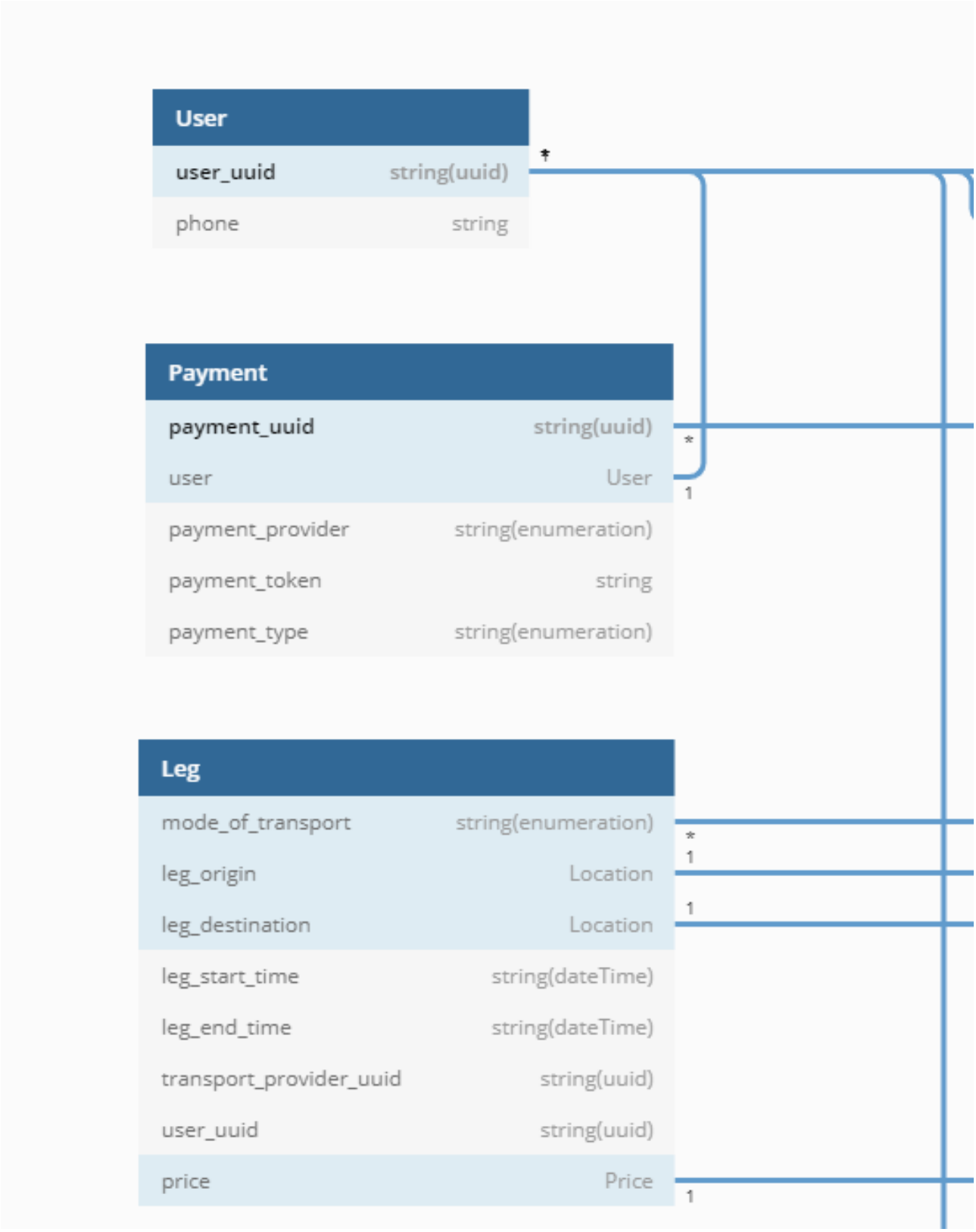

Figure 16 IMOVE Reference Data model 1/18

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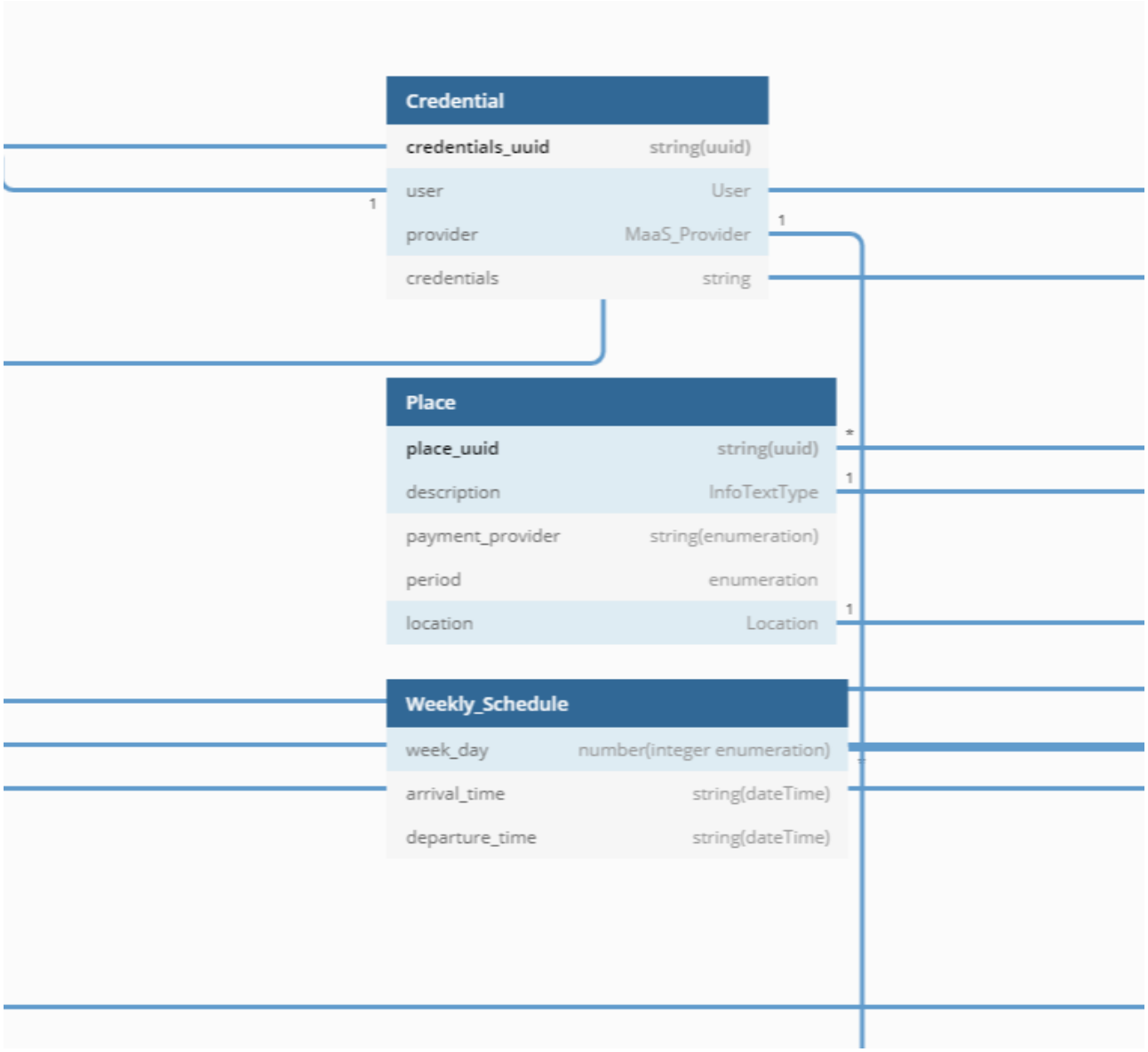

Figure 17 IMOVE Reference Data model 2/18

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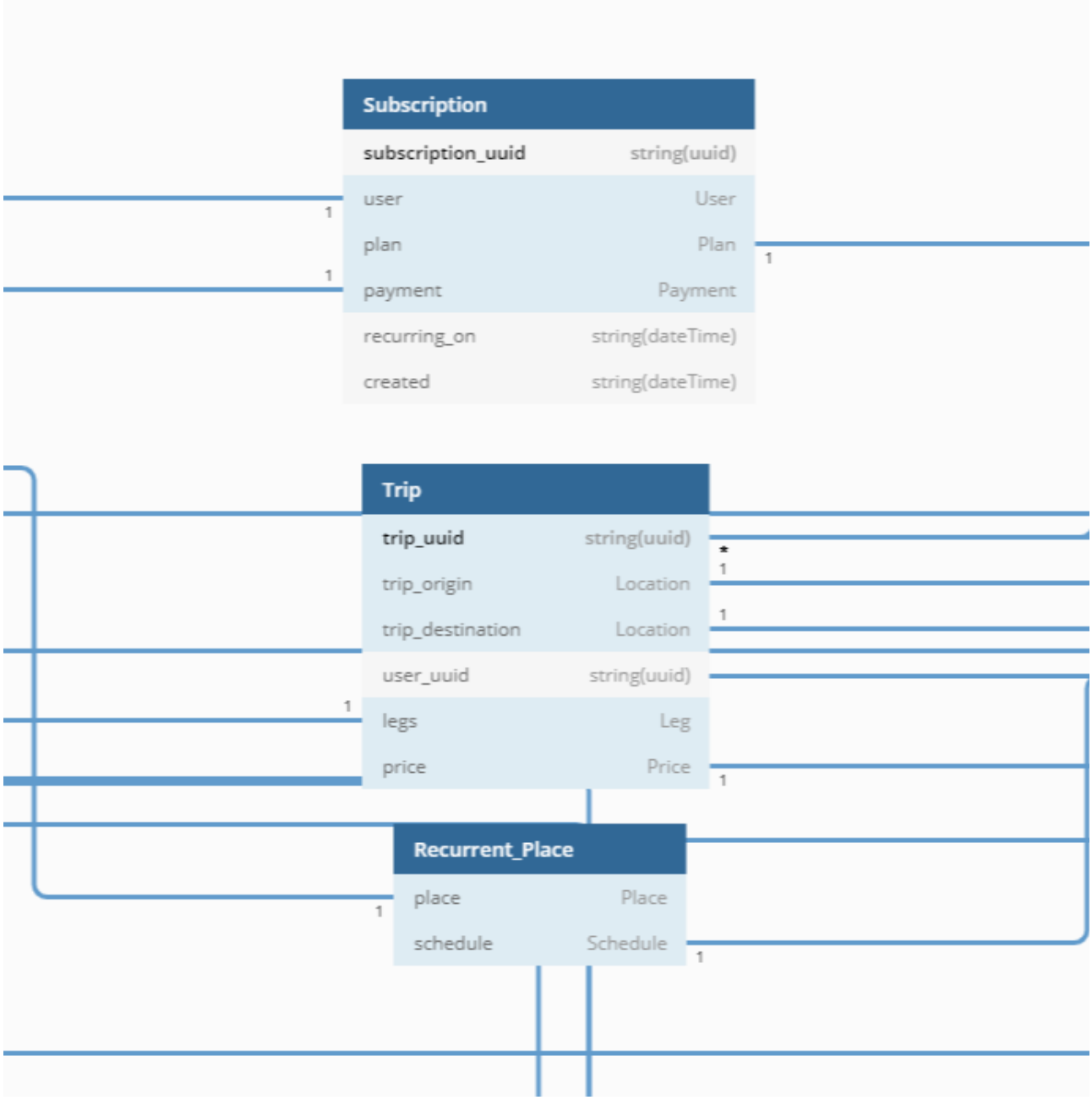

Figure 18 IMOVE Reference Data model 3/18

This report is part of a project that has received funding by the European Union's Horizon 2020 research and innovation programme under grant agreement number 723314.

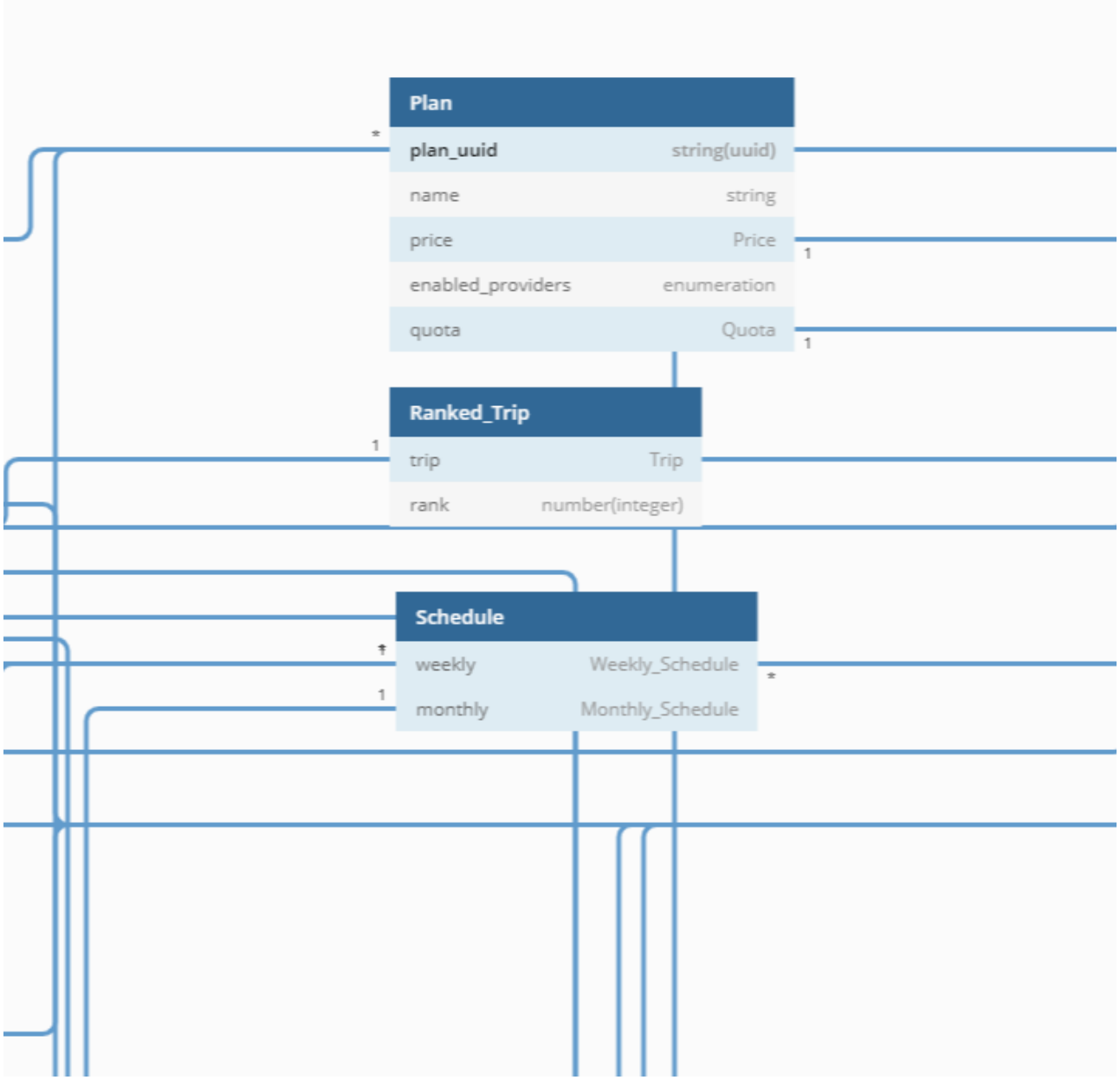

Figure 19 IMOVE Reference Data model 4/18

This report is part of a project that has received funding by the European Union's Horizon 2020 research and innovation programme under grant agreement number 723314.

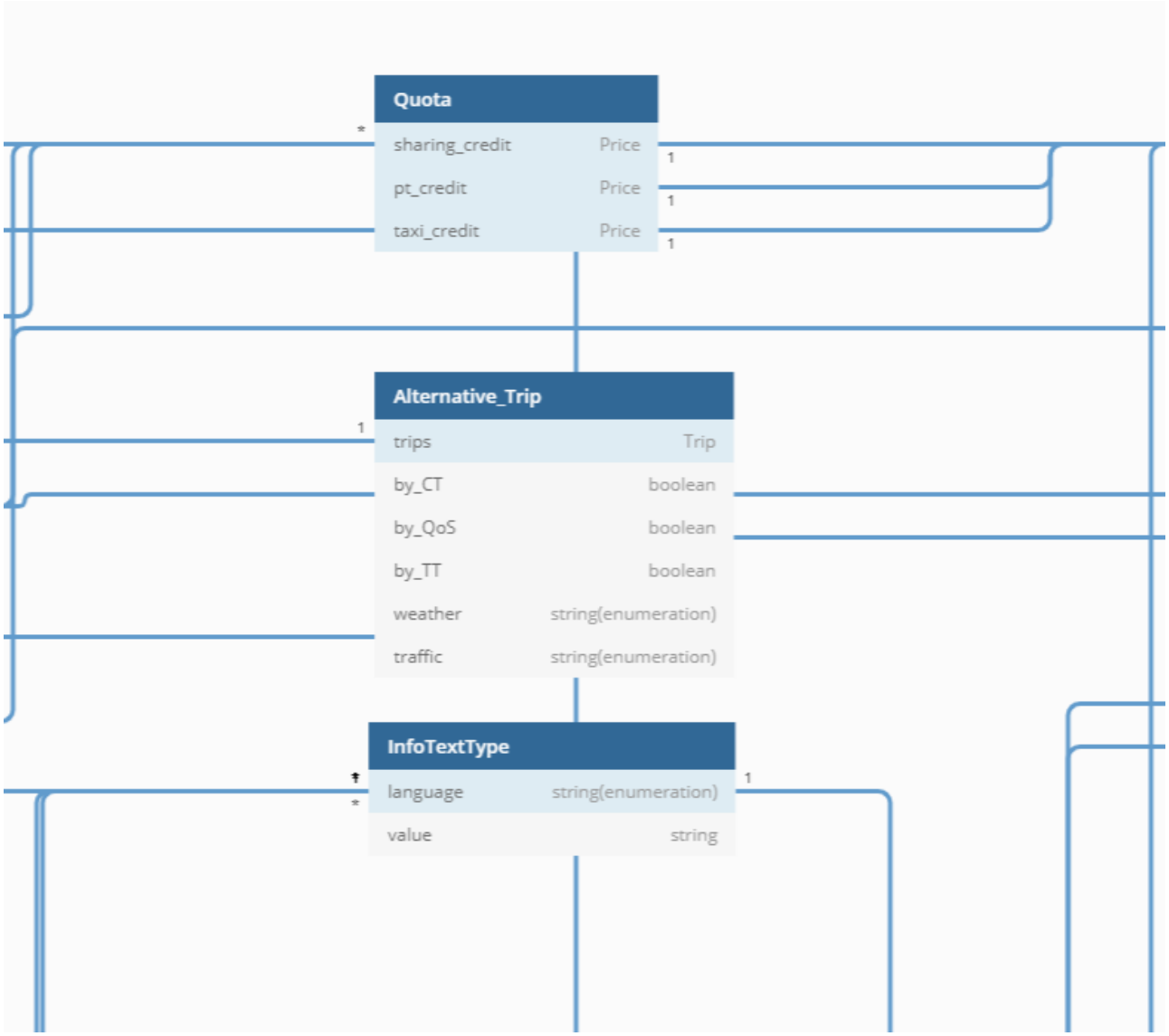

Figure 20 IMOVE Reference Data model 5/18

This report is part of a project that has received funding by the European Union's Horizon 2020 research and innovation programme under grant agreement number 723314.

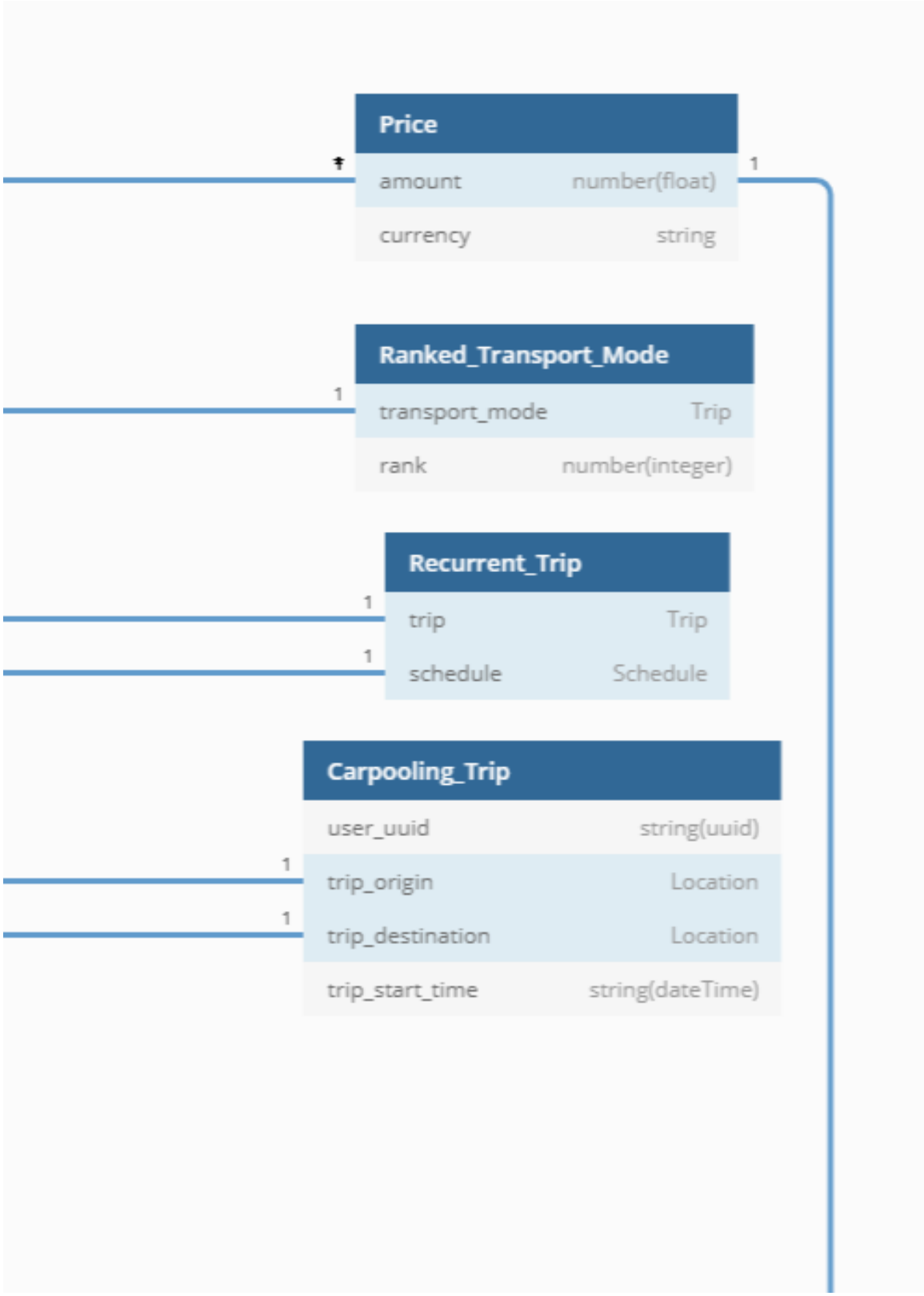

Figure 21 IMOVE Reference Data model 6/18

This report is part of a project that has received funding by the European Union's Horizon 2020 research and innovation programme under grant agreement number 723314.

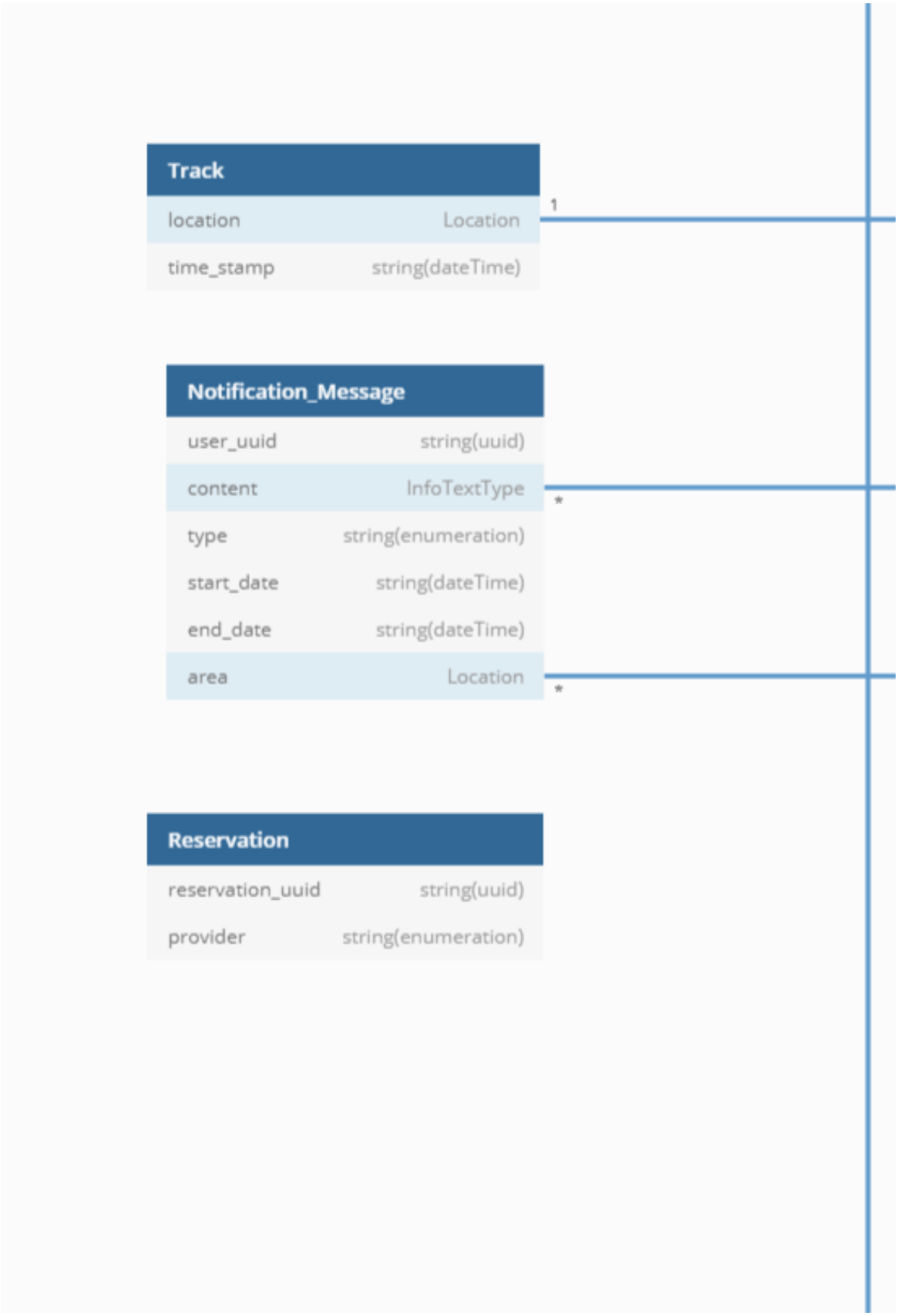

Figure 22 IMOVE Reference Data model 7/18

This report is part of a project that has received funding by the European Union's Horizon 2020 research and innovation programme under grant agreement number 723314.

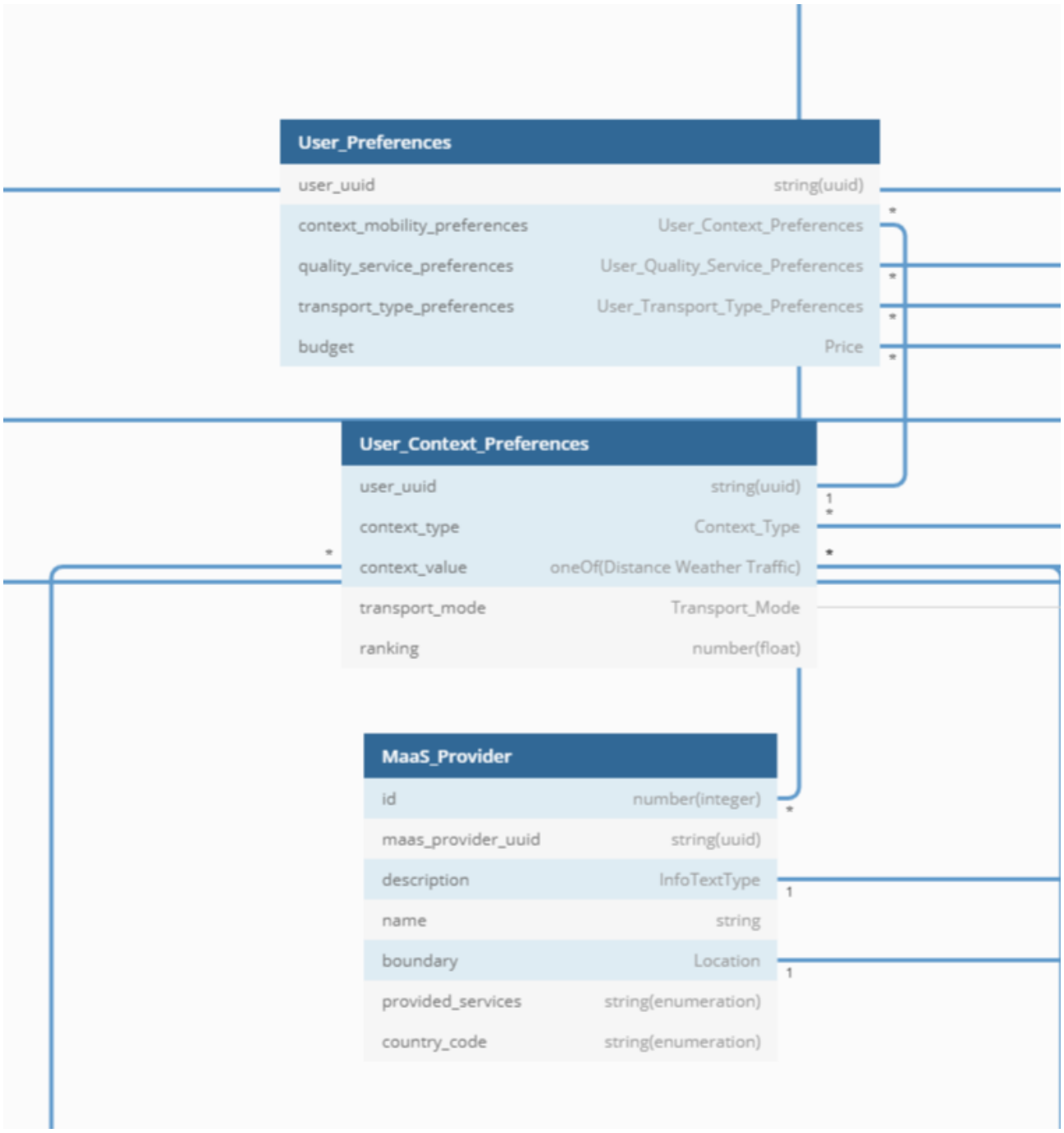

Figure 23 IMOVE Reference Data model 8/18

This report is part of a project that has received funding by the European Union's Horizon 2020 research and innovation programme under grant agreement number 723314.

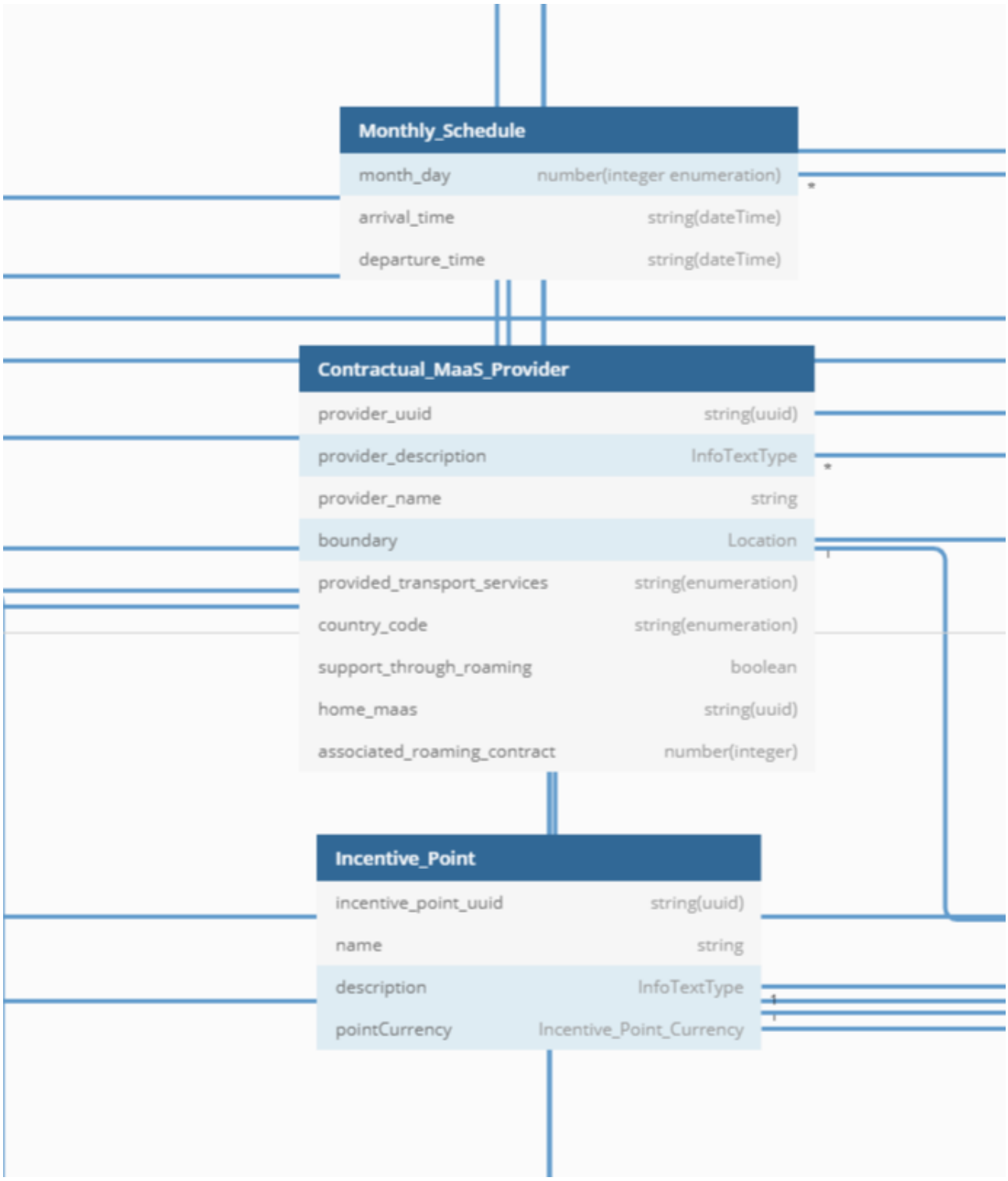

Figure 24 IMOVE Reference Data model 9/18

This report is part of a project that has received funding by the European Union's Horizon 2020 research and innovation programme under grant agreement number 723314.

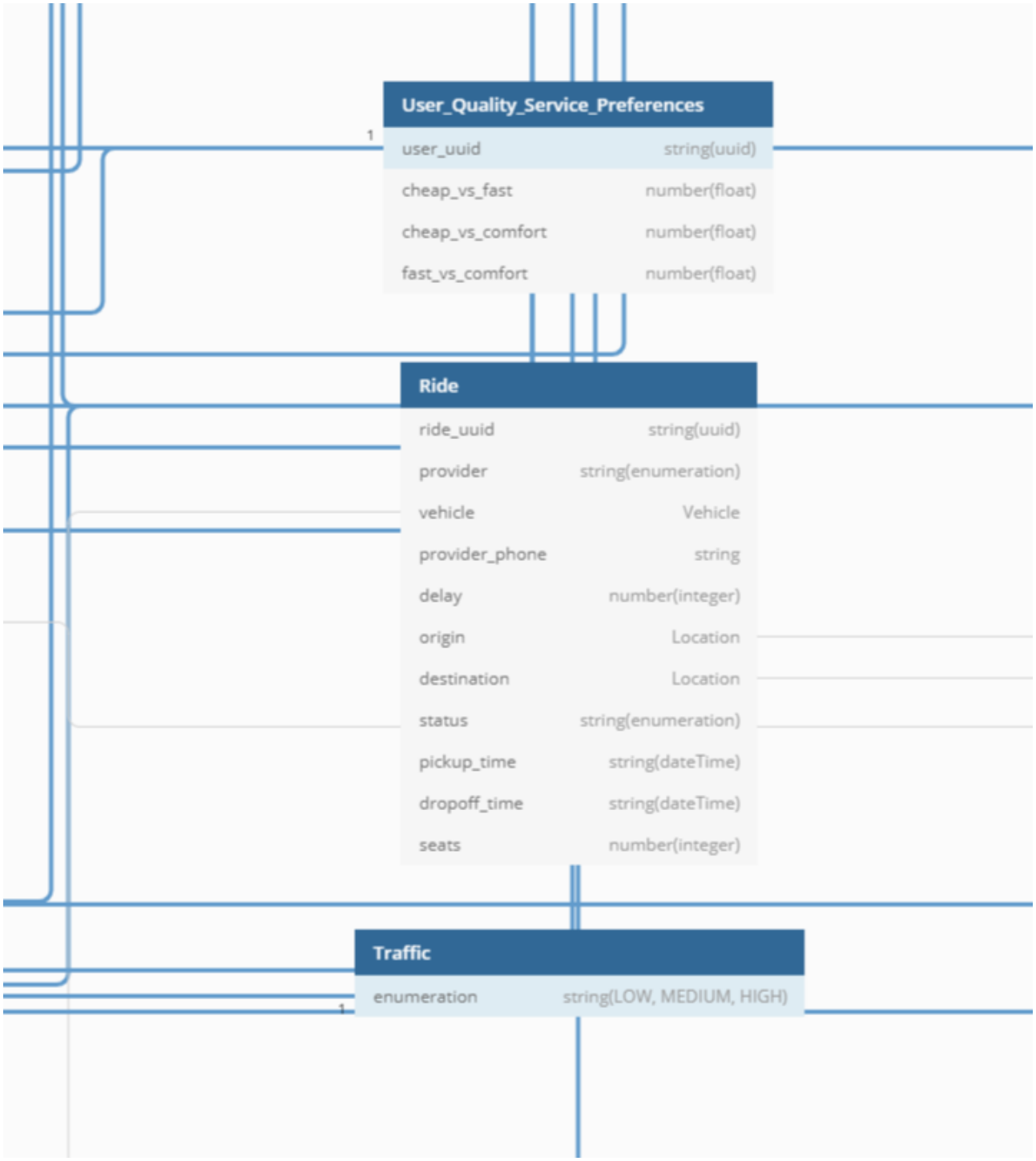

Figure 25 IMOVE Reference Data model 10/18

This report is part of a project that has received funding by the European Union's Horizon 2020 research and innovation programme under grant agreement number 723314.

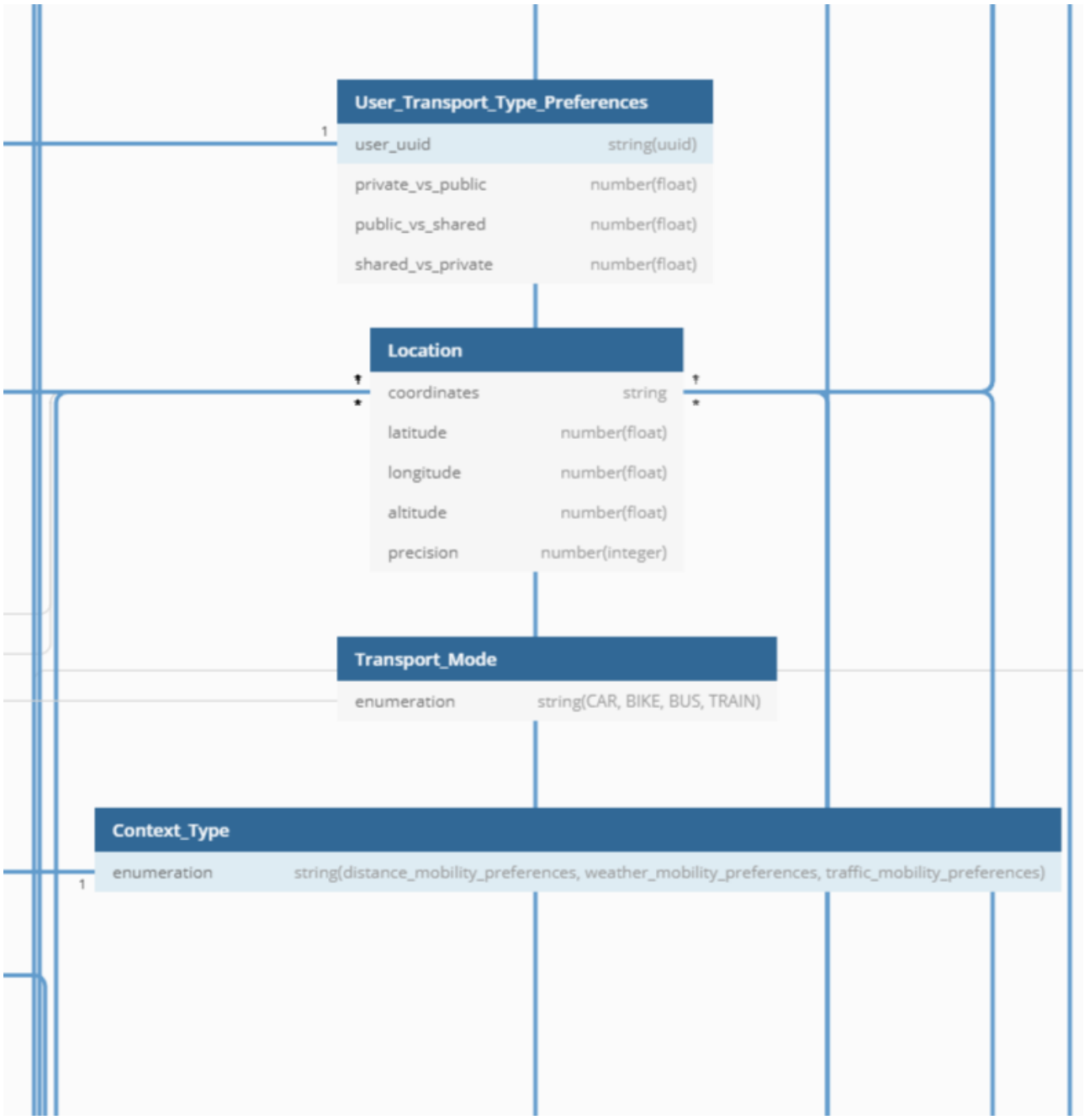

Figure 26 IMOVE Reference Data model 11/18

This report is part of a project that has received funding by the European Union's Horizon 2020 research and innovation programme under grant agreement number 723314.

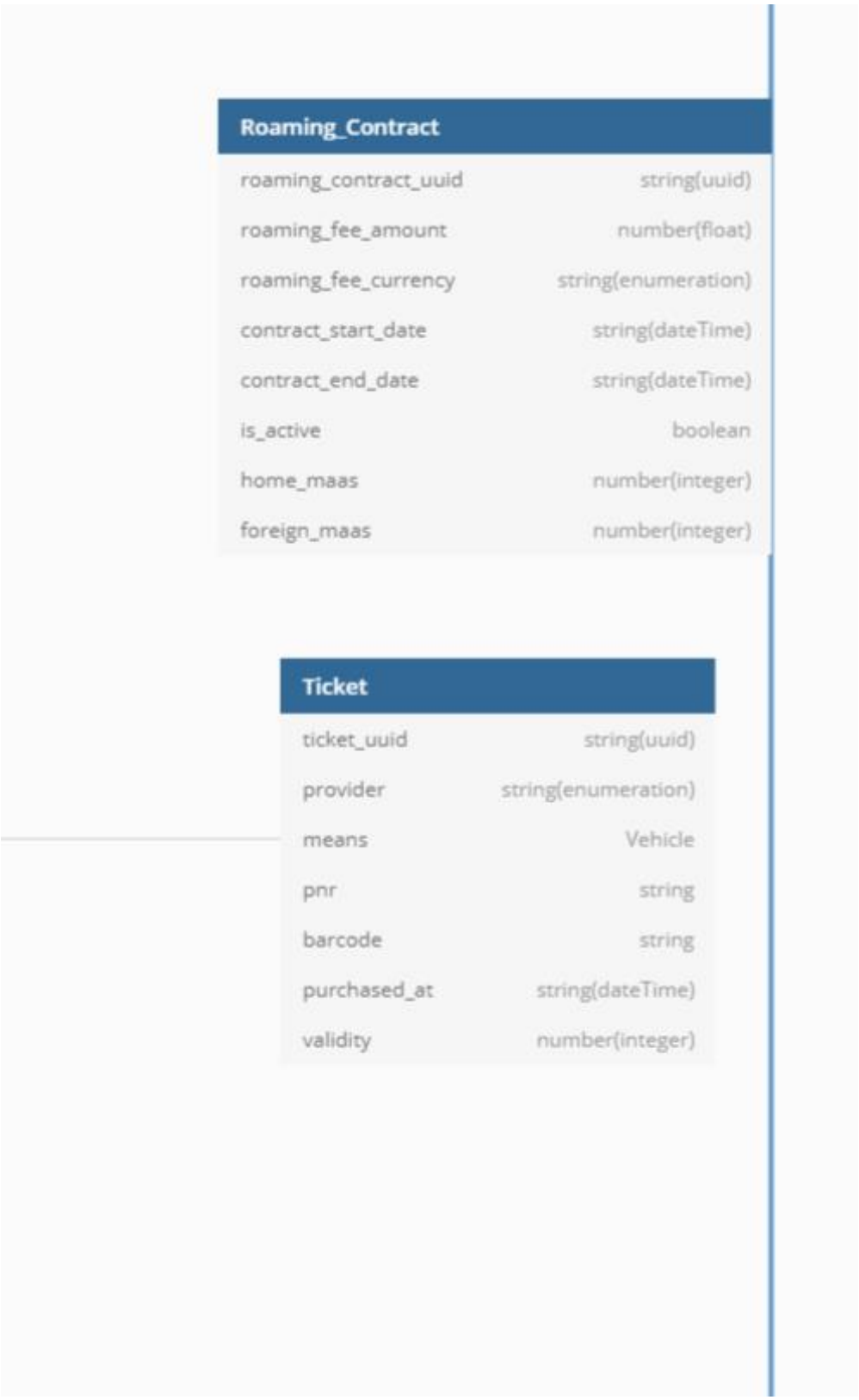

Figure 27 IMOVE Reference Data model 12/18

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Figure 28 IMOVE Reference Data model 13/18

This report is part of a project that has received funding by the European Union's Horizon 2020 research and innovation programme under grant agreement number 723314.

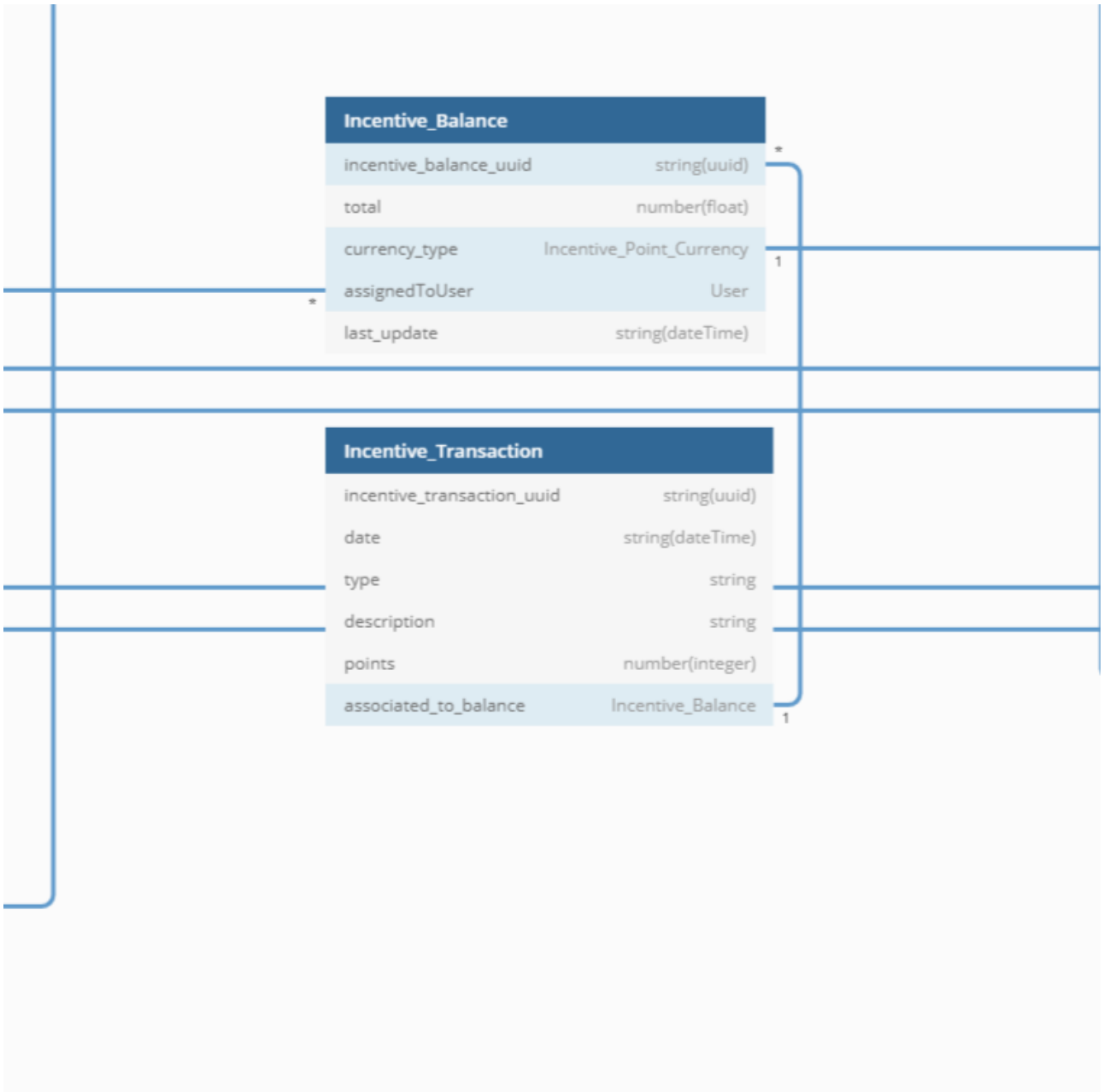

Figure 29 IMOVE Reference Data model 14/18

This report is part of a project that has received funding by the European Union's Horizon 2020 research and innovation programme under grant agreement number 723314.

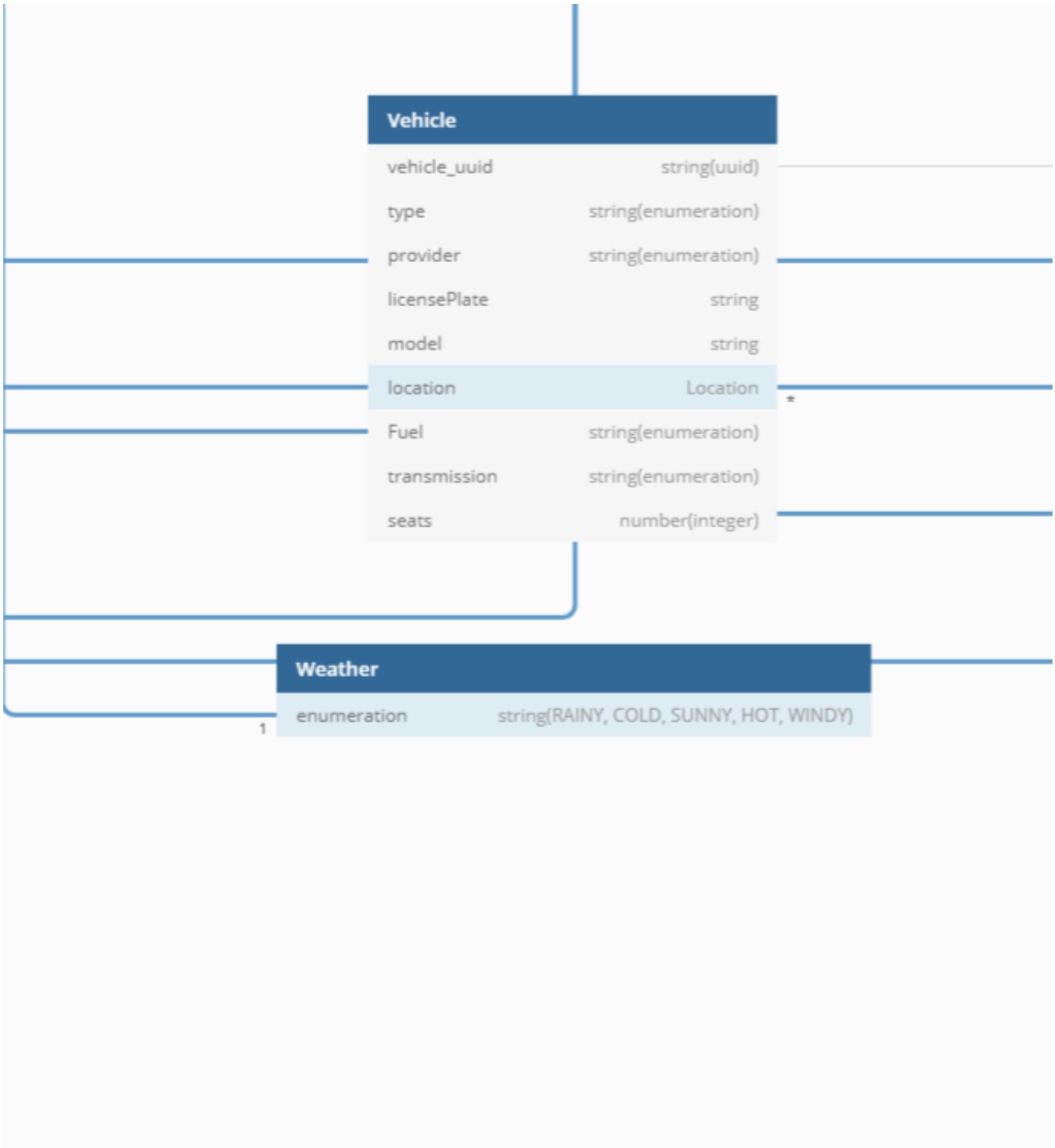

Figure 30 IMOVE Reference Data model 15/18

This report is part of a project that has received funding by the European Union's Horizon 2020 research and innovation programme under grant agreement number 723314.

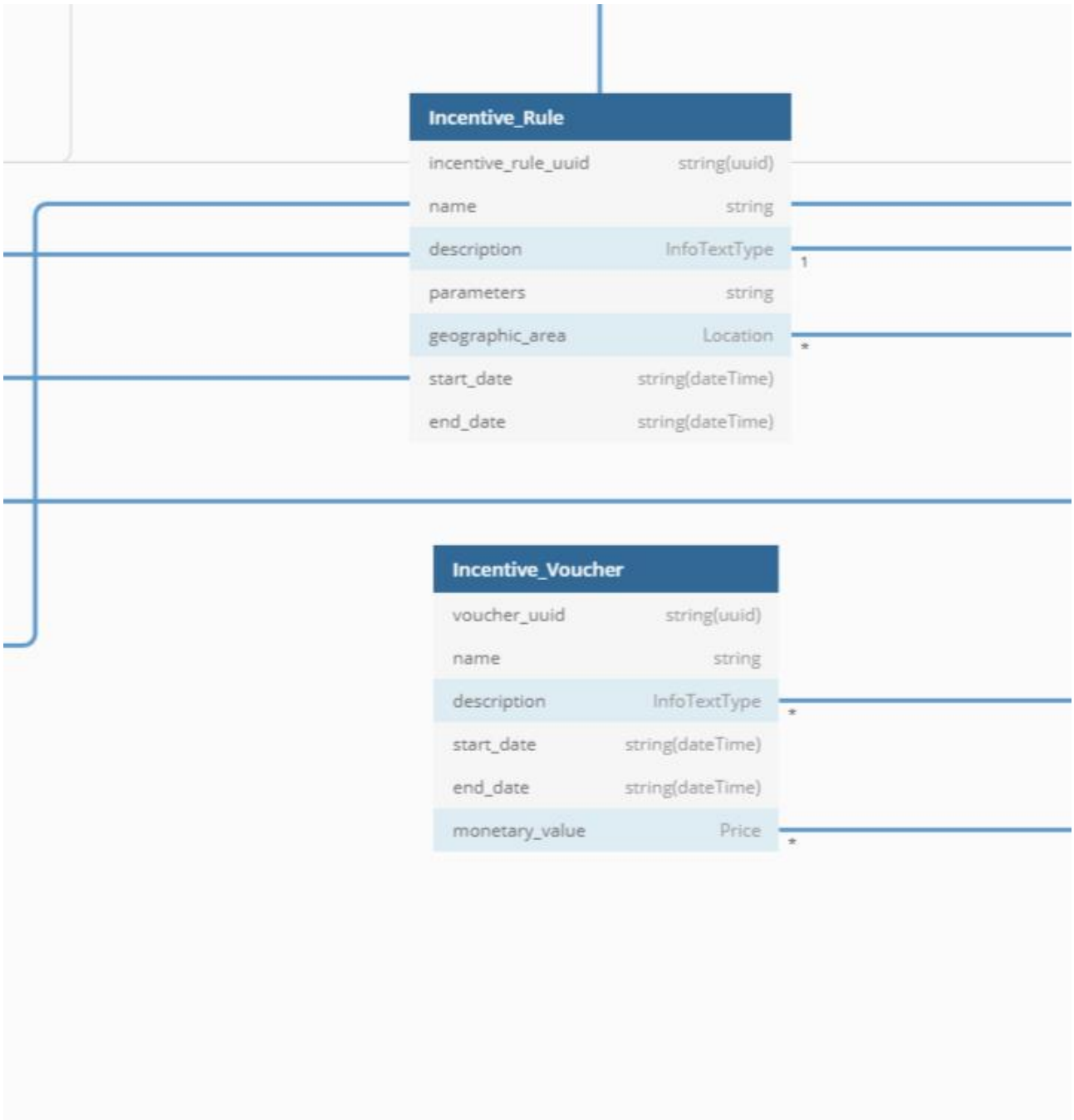

Figure 31 IMOVE Reference Data model 16/18

This report is part of a project that has received funding by the European Union's Horizon 2020 research and innovation programme under grant agreement number 723314.

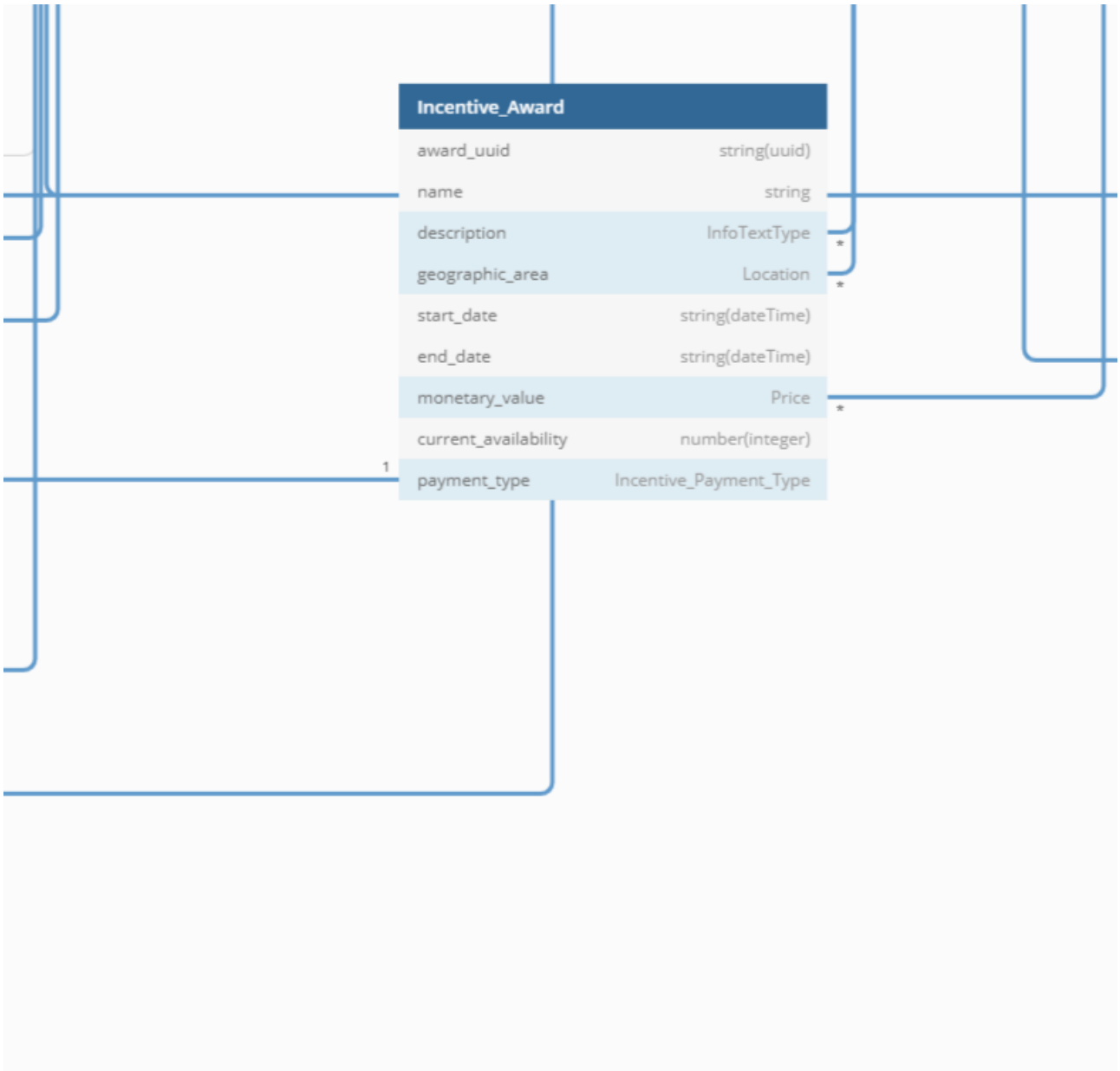

Figure 32 IMOVE Reference Data model 17/18

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Figure 33 IMOVE Reference Data model 18/18

This report is part of a project that has received funding by the European Union's Horizon 2020 research and innovation programme under grant agreement number 723314.

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